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Canada

PEAT SLURRY PUMPING/PIPELINE TRIALS

ON A

CANADIAN PEATLAND SITE

RENEWABLE ENERGY BRANCH

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EXECUTIVE SUMMARY

After an extensive review of alternative test site locations potentially offered in 4 provinces, a site was selected near Gravenhurst, Ontario which offered suitable access, variation of peat type and degree of decomposition, adequate water supply, minimum site preparation and other features considered important in project budget and schedule control. Considerable areas of the bog were open, without tree cover.

At the actual excavation site a thin, unhumified layer of peat occurred at the surface. Below that, sphagnum - dominated peats (sedge - sphagnum) with a degree of humification of H7 were found to a depth of 1.5m. Below this, quite pure sedge peat with some sphagnum were dominant with a degree of humification varying from H5 to H9. Basal material was usually sand or silty sand with some clay, but it was not uncommon to encounter a layer of ooze below the peat varying in thickness from a few centimeters up to 5 meters. The influence of the ooze layer appears responsible for higher ash content peat slurries than had been expected based on the initial laboratory analyses of peat samples recovered from hand augering.

During initial reconnaissance sampling of the peat deposit, an average ash content of 7.7% was reported, based on excluding basal material exceeding 25% ash. Later sampling of the actual mining site area, which included all peat to what was considered reasonable mining depth, indicated an ash content of about 11 to 12%, with minor amounts of basal material included in the samples.

At the actual excavation site the peat layer was underlain by ooze of variable thickness which proved to be easily pentrated by the water jets during mining and resulted in relatively high ash contents in most of the peat slurries. The depth of peat encountered at the test site (up to 2.3m) is considered about minimum for use of the "hydropeat" mining system. As well, thinner layers require re-positioning of equipment more often with resultant loss of equipment availability.

The test site had a high stump content (2.6%). This feature was considered important for evaluation of the mining system performance since the presence of stumps, roots, woody remnants and other debris is known to adversely affect peat extraction considerably. The mining equipment set worked well in this environment, although considerable additional water was required to wash peat free of stumps and roots and the stumps adsorbed the impact of the water. The high stump content is considered to have resulted in overall lower slurry solids concentration levels than would have otherwise been achieved.

A considerable amount of site preparation and equipment set-up was required prior to actual testing including ditching, preparation of a water reservoir, barge launching pool, clearing the slurry drying fields and installation of the various equipment and pipelines. Although the bog area was not extensively drained, a number of ditches were placed for general surface water control in the mining and drying field areas.

The modified "hydropeat" mining method used in the test is a practical method of harvesting peat. Peat was successfully excavated in slurry form from the bog and transported by pipeline to drying fields (elsewhere on the bog) where the slurry was readily contained within berms made of peat. Water and very fine particles of peat rapidly filtered through the top layer of undecomposed peat (30 to 50 cm) to the level of the more decomposed peat where it flowed sheet-like into the surrounding ditches. The discharge water was quite dark in colour, but returned to normal colouration after a few days.

The scow-mounted "hydropeat" equipment operated well in an "undrained" peatland environment and provided confirmation of the viability of larger commercial scale systems. Equipment moves were somewhat restricted due to the pipeline connections and power supply cable, but it is expected this aspect could be improved upon in a commercial operation. Development of an extraction plan for an entire bog would require detailed consideration of placement of the active mining faces, berms, control of the peat slurry pond, and type, condition and profile of basal material, overall peat recovery, etc.

Table 4-2 (average performance data) and Appendix A contain the actual pumping test results including peat extraction rates. Solids concentration varied considerably during testing; during test 1, run 3 a solids content of 3.7% (by weight) peat slurry was achieved at 22.5% (dry weight) ash content. Higher solids concentrations were obtained (e.g. 6.3%) but at much higher ash content. An ash content of about 25% (dry weight) is considered maximum for good quality fuel peat.

Table 5-6 shows that the best overall pump performance was achieved on the water tests, followed by the 1000 rpm/0.03 inch clearance pump configuration on peat slurry, which was higher than the 800 rpm/0.03 inch clearance and 800 rpm/0.5 inch clearance peat slurry results. However, it appears that higher average solids concentrations were obtained at the 800rpm/0.03 inch clearance pump operating conditions, which reflects total peat tonnage transported.

For the design of peat slurry pump/pipeline system the following conclusions have been reached:

- The relationship between velocity and viscosity does not appear to be important for the high rates of shear and turbulent conditions encountered in a prototype system.

- Concentration and viscosity can be predicted for each type of peat from equations similar to Equation 5.2.

- The pump characteristics curves developed from the test data illustrate the effect of the slurry solids content on the head produced by the pump. The data may be used for preliminary design of a peat pumping system and indicate the importance of including solids content as one of the parameters used in pump manufacturers' performance testing.

- The pump power demand will be greater and the efficiency will be lower when pumping slurry than when pumping clear water. Direct measurement of this parameter will also be required for detailed design of commercial peat slurry pump/pipeline systems.

- The pump/pipeline system is hydraulically stable and yields a consistent relationship between the slurry velocity and the head loss in the pipeline.

- A relationship between the head loss in the pipeline and the solids content of the slurry apparently does exist. However, this relationship is not as important as the relationship between head loss and velocity.

- The head loss from the test program can be scaled to give head losses for different pipeline diameters. The scaling procedure can be carried out for the solids content used in the test program. If other solids contents are required for design, interpolations may be carried out. For design of commercial systems with different peats, pilot tests will be required to provide scale data.

- Friction losses in the pipeline can be determined by the empirical Russian formula, Equation 5.5. The test program confirms the applicability of this formula for pipeline diameters of 300mm. The formula is generally applicable to peat slurry head loss in pipelines and is independent of the characteristics of the pump.

- The Russian formula includes viscosity measured at a constant shear rate. In the formula, the variation of the viscosity with velocity is not taken into account, therefore, it has limitations in its application to slurries with a wide range of viscosity. However, because the formula relies mainly on the velocity to predict the head loss, it does give a reasonable estimate of the head loss. However, a better correlation can be found by scaling the test data.

- The "critical length", beyond which further increases in pipeline length have little effect on the system flowrate appears to occur because of the relationship between the pump characteristic and pipeline curves. This effect can be illustrated for clear water pipelines and apparently becomes more noticeable as the solids content affects the pump head and friction losses. Further study would be required to separate the variations caused by the hydraulic systems from those caused by the mining operation.

- The current test program was designed to test the feasibility of potential commercial scale hydraulic peat mining systems. If further research is carried out it should include detailed rheological studies and laboratory determination of head losses to develop a generalized analytical model to reduce or eliminate the need for pilot testing of future commercial slurry systems. Because of the difficulty in developing generalized theoretical design procedures, the design of peat slurry pump/pipeline systems should be based on the rheological properties of the specific peat types and systems being considered. The methodology developed from the laboratory studies will require confirmation through further monitoring of prototype installations for development of design procedures, theoretical background and optimization of the systems.

SOMMAIRE

Après un examen approfondi d'autres emplacements d'essai possibles dans quatre provinces, un emplacement situé près de Gravenhurst (Ontario) fut retenu; cet emplacement offrait des possibilités d'accès convenables, une variation du type de tourbe et du degré de décomposition ainsi qu'un approvisionnement en eau adéquat tout en n'exigeant qu'une préparation minimale et présentait d'autres caractéristiques considérées importantes pour l'administration du budget et le respect de l'échéancier. Des étendues considérables de la tourbière étaient déboisées.

À l'emplacement d'excavation même, on trouvait à la surface une mince couche de tourbe non humifiée. Sous cette couche, des tourbes où dominait la sphaigne (carex-sphaigne) avec un degré d'humification de H7 étaient présentes jusqu'à une profondeur de 1,5 m. Enfin, sous ces tourbes dominait une tourbe laîche très pure avec un peu de sphaigne et dont le degré d'humification variait de H5 à H9. Le matériau de base était habituellement du sable ou du sable limoneux avec un peu d'argile, mais il n'était pas rare de trouver sous la tourbe une couche de boue dont l'épaisseur variait de quelques centimètres à 5 mètres. Les suspensions de tourbe obtenues présentaient des teneurs en cendres plus élevées que celles prévues lors des analyses initiales en laboratoire effectuées sur des échantillons de tourbe recueillis à la tarière à main et cela serait attribuable à l'influence de la couche de boue.

Lors de l'échantillonnage initial de reconnaissance du gisement de tourbe, une teneur en cendres moyenne de 7,7 % a été signalée; cette teneur était basée sur l'exclusion du matériel de base renfermant plus de 25 % de cendres. Lors d'un échatillonnage ultérieur de la zone même de l'emplacement d'exploitation, et qui englobait toute la tourbe jusqu'à une profondeur exploitable jugée raisonnable, la teneur en cendres s'établissait à environ 11 à 12% lorsque des quantités mineures de matériaux de base étaient incluses dans les échantillons.

À l'emplacement même d'excavation la couche de tourbe reposait sur une boue d'épaisseur variable qui s'est avérée facilement pénétrable par les jets d'eau pendant l'exploitation, ce qui a donné des teneurs en cendres relativement élevées dans la plupart des suspensions de tourbe. La profondeur de tourbe à l'emplacement d'essai (jusqu'à 2,3 m) est considérée à peu près minimale pour l'exploitation au moyen du système "hydropeat". Des couches plus minces obligent à repositionner plus souvent l'équipement qui est alors d'autant moins disponible.

L'emplacement d'essai présentait une teneur élevée en souches (2,6%). Cette caractéristique était jugée importante pour l'évaluation du rendement du système d'exploitation puisque la présence de souches, de racines, de restes ligneux et d'autres débris nuit considérablement à l'extraction de la tourbe. L'équipement d'exploitation fonctionnait bien dans ce milieu quoique l'eau ait été nécessaire en quantités additionnelles considérables pour séparer la tourbe des souches et des racines et que les souches absorbaient l'impact de l'eau. Il est considéré que la teneur élevée en souches a entraîné des concentrations moindres en matières solides en suspension que cela n'aurait été par ailleurs le cas.

Des travaux considérables de préparation de l'emplacement et d'installation de l'équipement ont été nécessaires avant que puissent être effectués les essais; parmi ces travaux mentionnons le creusement de fossés, la préparation d'un réservoir d'eau et d'un bassin de mise à l'eau du chaland, le déboisement des champs de séchage de la suspension et l'installation de diverses pièces d'équipement et des pipelines. Quoique la zone de la tourbière n'ait pas été drainée de manière poussée, un certain nombre de fossés ont été creusés pour permettre l'écoulement général des eaux de surface dans les zones d'exploitation et les champs de séchage.

La méthode "hydropeat" modifiée d'exploitation utilisée lors de l'essai s'avère une méthode pratique de récolte de la tourbe. La tourbe a été recueillie avec succès de la tourbière sous forme de suspension et transportée par pipeline aux champs de séchage (ailleurs dans la tourbière) où la suspension était facilement contenue au moyen de bermes fabriquées de tourbe. L'eau et les très fines particules de tourbe filtraient rapidement au travers de la couche supérieure de tourbe non décomposée (30 à 50 cm) jusqu'au niveau de la tourbe plus décomposée où elles s'écoulaient en nappe jusqu'aux fossés environnants. L'eau évacuée était de couleur très foncée, mais reprenait une couleur normale après quelques jours.

L'équipement "hydropeat" monté sur chaland a bien fonctionné dans la tourbière "non drainée" et a permis de confirmer la viabilité de systèmes commerciaux de plus grande envergure. Les déplacements de l'équipement étaient quleque peu restreints par les raccords de pipelines et le câble d'alimentation en énergie, mais il est prévu que cet aspect pourrati être amélioré dans une exploitation commerciale. L'élaboration d'un plan d'extraction pour l'ensemble d'une tourbière exigerait une prise en considération détaillée des emplacements des fronts d'exploitation actifs, des bermes, du confinement de l'étang pour suspension de tourbe ainsi que du type, de l'état et du profil du matériau de base, de la récupération globale de tourbe, etc.

Le tableau 4-2 (données sur le rendement moyen) et l'appendice A présentent les résultats des essais véritables de pompage incluant les taux d'extraction de tourbe. La concentration de matières solides a varié considérablement pendant les essais. Lors du passage 3 de l'essai 1 on a obtenu une suspension de tourbe d'une teneur en matières solides de 3,7 % (en poids) et d'une teneur en cendres de 22,5 % (poids sec). Des concentrations plus élevées de matières solides ont été obtenues (p. ex. 6,3 %), mais avec des teneurs en cendres beaucoup plus élevées. La teneur maximale en cendres d'une tourbe combustible de bonne qualité est considérée d'environ 25 % (poids sec).

Le tableau 5-6 indique que le meilleur rendement global de la pompe a été obtenu dans le cas des essais avec de l'eau, puis dans le cas d'une configuration de la pompe pour particules de tourbe en suspension de 0,03 po à 1000 t/mn, rendement qui était supérieur à ceux obtenus pour 800 t/mn/0,03 po et pour 800 t/mn/0,5 po. Toutefois, il semble que des concentrations moyennes plus élevées de matières en suspension étaient obtenues lorsque la pompe était exploitée à 800 t/mn/0,03 po, concentrations reflétées par les quantités totales de tourbe transportées.

Pour ce est de la conception du système pompe/pipeline pour suspension de tourbe on a tiré les conclusion suivantes:

- La relation entre vitesse et viscosité ne semble pas importante dans le cas des taux élevés de cisaillement et des conditions turbulentes observées pour le prototype de système.

- La concentration et la viscosité peuvent être prévues pour chaque type de tourbe d'après des équations analogues à l'équation 5.2.

- Les courbes des caractéristiques de la pompe établies d'après les données d'essai illustrent l'effet de la teneur en matières solides en suspension sur la charge hydraulique produite par la pompe. Les données pourraient être utilisées pour la conception préliminaire d'un système de pompage de la tourbe et indiquent l'importance de l'inclusion de la teneur en matières solides parmi les paramètres lors des épreuves de rendement de la pompe effectuées par le fabricant.

- La puissance appelée par la pompe sera plus grande et le rendement moindre lors du pompage d'une suspension que lors du pompage d'eau limpide. La mesure directe de ce paramètre sera également nécessaire pour la conception détaillée de systèmes commerciaux pompe/pipeline pour suspensions de tourbe.

- Le système pompe/pipeline est hydrauliquement stable et il existe une relation uniforme entre la vistesse de la suspension et la perte de charge dans le pipeline.

- Il existe apparemment une relation entre la perte de charge dans le pipeline et la teneur en matières solides de la suspension. Toutefois, cette relation n'est pas aussi importante que la relation entre perte de charge et vitesse.

- La perte de charge observée dans le cadre du programme d'essai peut être modifée pour des pipelines de diamètres différents. La procédure de modification peut être appliquée pour les teneurs en matières solides utilisées dans le cadre du programme d'essai. Si d'autres teneurs en matières solides sont exigées pour la conception, des interpolations pourraient être effectuées. Pour la conception de systèmes commerciaux d'exploitation de différentes tourbes, des essais-pilotes seront nécessaires pour l'obtention des données de modification.

- Les pertes par frottement dans le pipeline peuvent être déterminées au moyen de la formule empirique russe, équation 5.5. Le programme d'essai confirme l'applicabilité de cette formule aux pipelines d'un diamètre de 300 mm. La formule est généralement applicable à la perte de charge des suspensions de tourbe dans les pipelines et est indépendante des caractéristiques de la pompe.

- La formule russe tient compte de la viscosité mesurée à un taux de cisaillement constant. Cette formule ne tient pas compte de la variation de la vicosité en fonction de la vitesse et par conséquent son application à des suspensions présentant une plage étendue de viscosités comporte des limites. Cependant, puisque la formule fait principalement intervenir la vitesse pour prédire la perte de charge, elle fournit une estimation raisonnable de la perte de charge. Toutefois, une meilleure corrélation peut être établie en adaptant les données d'essais aux diamètres des pipelines.

- La "longueur critique" au-delà de laquelle de nouveaux accroissements de la longueur du pipeline n'auront que peu d'effets sur la vitesse d'écoulement dans le système semble dépendre de la relation entre les caractéristiques de la pompe et les courbes du pipeline. Cet effet peut être illustré dans le cas de pipelines pour eau limpide et devient apparemment plus appréciable à mesure que la teneur en matières solides influence la charge hydraulique de la pompe et les pertes par frottement. Une étude plus approfondie serait nécessaire pour séparer les variations causées par les systèmes hydrauliques de celles causées par l'opération d'extraction.

- L'actuel programme d'essai a été conçu afin d'éprouver la faisabilité d'éventuels systèmes hydrauliques d'extraction de la tourbe à l'échelle commerciale. Si des recherches plus approfondies sont effectuées, elles devraient comporter des études rhéologiques détaillées et des déterminations en laboratoire des pertes de charge pour la mise au point de modèles analytiques généralisés permettant de réduire ou d'éliminer les essais-pilotes de futurs systèmes commerciaux utilisant des suspensions. En raison de la difficulté que pose l'élaboration de procédures théoriques généralisées de conception, la conception de systèmes pompe/pipeline pour suspensions devrait être basée sur les propriétés rhéologiques des types de tourbe et des systèmes spécifiques envisagés. La méthodologie dérivée des études en laboratoire devra être confirmée par une surveillance supplémentaire des prototypes d'installations permettant d'élaborer des procédures de conception et un cadre théorique ainsi que d'optimiser les systèmes.

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PART 1

INTRODUCTION

PART 1 - INTRODUCTION

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1.1 BACKGROUND

The Term "Wet Peat Mining"

By the term "wet peat mining", is meant extraction methods used to remove peat directly from a peat deposit usually in the form of a slurry, by pumping and pipeline transport.

Current "Dry" Peat Production

Currently, almost all large-scale production of peat is by dry mining methods, i.e., use of drained bog, milling of a very thin surface layer, solar-drying of the milled layer, collection of the dried material and storage in stockpiles. It is estimated some 150-190 million tonnes of air-dried peat (40-50% moisture content) is currently produced in the USSR, using almost exclusively dry peat mining techniques. Although it is almost impossible to locate reliable employment figures for the Russian peat industry, information shows that at least 20,000 people are employed in the industry in the USSR, and in all likelihood, considerably more. Finland produces approximately 4 million tonnes of peat annually, and employs 2,500-3,000 people, directly. Irish production is approximately 5-6 million tons per year (using dry mining techniques) and employs approximately 4,000-5,000 people in the peat industry. The above-mentioned statistics apply to total peat production including horticultural, agricultural, fuel peat, etc. The Canadian horticultural peat industry produces approximately 400,000 tonnes of air-dried peat per year and provides employment for approximately 1,200 people in the peat industry.

Disadvantages of "Dry" Mining Techniques

The main disadvantage of dry peat mining is the short harvesting season, during which operations are highly dependent on weather conditions to achieve targetted production goals. The production season usually starts some time in May and lasts until the end of August or possibly into early September, at most Canadian locations. During this period, weather can create havoc with production schedules. An example can be taken from the Finnish experience of 1981, where the peat production was only 42% of that of 1982. Although research is being carried out in weather forecasting techniques to assist in peat production planning, problems of peat supply in bad years is still a major drawback of the current dry mining methods.

Dry mining methods currently in use require large production field areas which are extensively travelled by equipment during the various phases of peat production and collection. Yields per hectare vary, but a Monenco study for a 100,000 tonne per year fuel peat operation showed that up to 1,100 hectares of active mine area (excluding stockpile, roads, and other installation areas) could be required. The study was for a fuel peat operation to fuel a pulp and paper facility, so the size mentioned above is modest if a large-scale, peat-fired, thermal-electric power plant is considered.

As well, the environmental effects of drainage of large peatland areas must be considered.

Reasons for Interest in "Wet" Mining Techniques

Wet peat mining has the advantage of prolonging the production season from the approximately four month period available for dry peat mining to about 9-10 months, for most Canadian peat production locations. Wet peat mining is considerably less influenced by weather conditions.

It is estimated that wet peat mining would require approximately 10% of the active mining area, compared to dry mining methods, even when used on a drained peatland area. The active mining area required for wet mining on an undrained peatland would be even less. Furthermore, it is expected that the impacts of mining on the various environmental parameters could be considerably reduced.

Wet peat mining can also be considered if drainage of the peatland area is not possible, or difficult. Wet peat mining methods can be used on drained and undrained peat deposits.

Depending on the mining system employed, some wet peat mining techniques are well suited to peat deposits having a high stumps or wood content since the water-jets effectively wash the peat from the wood debris. Wood often causes considerable problems with conventional dry mining equipment, and the inclusion of woody remnants can detrimentally affect the final quality of the peat product.

Wet peat mining was practiced extensively in the USSR for over 40 years and production in the 1950's peaked at about 11 million tonnes of air-dried peat annually. By the early 1960's, it had largely been replaced by dry mining methods due primarily to the heavy manual labour requirement on the drying fields to manipulate the slurry pipeline network for slurry spreading, and the slow solar-drying process itself, which rarely allowed more than 1-2 "harvests" per season. Dry mining techniques proved more effective than wet mining techniques when solar-drying was the only means of dewatering to prepare the dried peat product.

With the high oil prices in the 1970's, an intensive effort began in Europe and later in North America to develop methods and technology to dewater and/or process various types of peat using wet-mined peat feedstock. In Finland, the JP-Energy "peat-derived fuel" process was stated to be ready for commercialization. In Canada, considerable work has been done on peat dewatering and processing including a "low-severity" dewatering process developed at the University of Sherbrooke and study on the use of microbes to dewater fuel peat carried out at McGill University. As well, some initial work was undertaken a few years ago in Europe by a private company on the "pumpability" of peat slurries utilizing bulk-excavated peat and processing the peat with a high-energy macerating device into a "homogenized" slurry, prior to pumping in loop tests. However, the results have not been generally available.

The need for investigation into peat slurry pumping and transport, as well as the overall mining system, has developed largely because of the R&D efforts in developing peat dewatering technology and peat processes which can accept peat in a slurry form. As advances occurred in peat dewatering and processing, it became obvious tht systems for extracting peat and delivering peat slurry to the dewatering or processing plant needed to be investigated.

Status of Information on Peat Slurry Rheology

Based on Monenco's investigations over the last 5-6 years, and also on the independent findings of others (e.g., the 1982 Dravo Engineers report on wet peat mining by cutterhead suction dredge carried out for the Gas Research Institute of Chicago, Illinois), there has been virtually no information available on the behaviour of peat in slurry form, in western countries.

The multi-volume Dravo report was an extensive engineering feasibility assessment carried out for a proposed large-scale peat development for a Minnesota location. Apparently, Dravo engineers visited the USSR to secure information on peat slurry mining methods, but their final comments in the report were as follows:

> "One major problem encountered in the slurry pond harvesting system design has been the lack of information on the slurry pumping characteristics for peat. Considerable time was spent researching literature on this subject without success."

Although there has been a lack of information in the west on peat slurry pumping information, this is not true for the USSR. Peat was pumped in slurry form for many decades and a considerable amount of statistical data on peat slurry pumping exists there, as well as information on the design of various mining systems and specially-built peat slurry pumps which were used to transport the peat slurry by pipeline for long distances, up to about 30 km. Monenco was able to obtain access to considerable information on peat slurry pumping from this source.

A series of projects have recently been carried out under the NRC's Energy R&D Program in the peat sector to study peat rheology and peat slurry pumping (culminating in the project described in this report), prior to phase-out of the NRC's Division of Energy. The first project was described in a report entitled "Development of Design Parameters for Peat Slurry Pumping and Pipeline Transport" by Monenco (Reference 1). Laboratory methods for determining degree of decomposition of peat and peat slurry viscosities were outlined. A correlation was made between Russian and North American peat and peatland types. Laboratory testing of peat samples from Saskatchewan, Ontario, New Brunswick and New York were carried out, and a comparison of the results obtained was made to the previous USSR information.

The following project involved a review of the previous USSR designs of peat slurry pumps, numerous discussions with North American, European and Japanese pump manufacturers, preparation of a new design of peat slurry pump and fabrication of same. Monenco engineers worked closely with the selected manufacturer. The construction of the proto-type peat slurry pump/macerator was completed in 1985 and the unit was shop tested on water. Pump performance on water exceeded design requirements. The unit was designed to operate at an industrial-scale (e.g., capacity 2,000-4,000 USgpm). The peat slurry pump has several unique features including an external propeller to repel roots, stumps and other debris and an internal macerating unit to prepare the peat, with a minimum energy input, into a form which renders it suitable for pumping and pipeline transport. This phase of the program also included a "run-in" test of the pump on a drained New York peatland site.

The current project represents the third phase, to carry out a full-scale mining and peat slurry pumping test on a virgin Canadian peatland site. A key aspect of the test was to demonstrate the use of an integrated mining and peat slurry pumping system. All the conditions expected to be encountered at a virgin peatland site were planned for during the test, i.e., potential peatland drainage problems, surface vegetation, woody remnants in the peat, operation of a barge within the mining pit, as well as settling tests on the peat slurry to study ways to increase its solids concentration.

1.2 PROJECT OBJECTIVES

A key objective of the peat slurry pumping and pipeline transport trials was to gain, through full scale field operating conditions on a typical Canadian peatland site, a detailed assessment of the performance of the pipeline and peat slurry pump, designed by Monenco as part of studies of a modified "hydropeat" wet peat mining method.

The interrelationship between the peat slurry pumping component of the project and the overall wet peat mining system has been well recognized. Previous investigators have postulated many novel ideas as a basis for conceptual design of wet peat mining systems. However, peatlands pose difficult problems of trafficability in both drained and partially drained states, so consideration of developing the slurry pumping system into an effective mining tool was a key element of the project.

1.3 UNITS

Although the bulk of measurements and calculations were carried out in the metric system, key information such as flowrates and clearance between the impeller and wear plate were measured in US gpm and inches, respectively, from gauges and manufacturers specifications in the same units. For the sake of convenience and accuracy in some cases, these units have been retained throughout the text.

PART 2

SITE SELECTION

PART 2 - SITE SELECTION

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2.1 SITE SELECTION PROGRAM

The first phase of work associated with the peat slurry pumping project involved selecting a site both technically and environmentally suitable for the test. In all, a total of 30 peatland areas were investigated in four provinces: Alberta (3), New Brunswick (2), Nova Scotia (10) and Ontario (15).

The suitability of each site was evaluated on the basis of the following criteria: sufficient surface area (90-100 ha), required peat thickness (3 m), variable peat types and degrees of humification, an ample supply of water, reasonable degree of drainability, a suitable area for slurry containment, presence of support facilities (repair shops, supplies), environmentally acceptable (not sensitive), preferably owned by a single owner, good access, and finally, the combined effect of the site parameters to allow the project to be carried out within the prescribed time and budget limits.

Of the three sites investigated in Alberta, the two located near Alsike (about 100 km southwest of Edmonton) were rejected due to either a lack of an adequate water supply, unsuitable peat quality or environmental considerations. The third site, the Hood Enterprises Bog (located 110 km west of Edmonton), which is presently being wet mined for the production of horticultural peat, was deemed unsuitable partly due to the uniformity of peat type, but mainly due to forseeable difficulties in scheduling the test around the existing commercial operation.

The two sites suggested by the Province of New Brunswick, one 5 km southeast of Newcastle, the other 13 km south of Chatham, were both considered not suitable because of poor access, uniformity of peat types and lack of an adequate water supply. The ten sites recommended for consideration by the Nova Scotia Department of Mines and

Energy were unacceptable largely due to poor access or lack of a sufficient water supply in close proximity.

Due to time and budget constraints, the investigation of potential test sites (15) in Ontario focussed on peatlands situated in the southern half of the Province. As with the Nova Scotia sites, most Ontario sites were characterized by either poor accessibility or lack of an ample water supply or both. However, one site near Gravenhurst, the McLaughlin Bog, met each selection criteria sufficiently well and was eventually chosen. A detailed description of the site follows in the next section.

For a more detailed description of the site selection portion of the work, the reader is referred to the Monenco report entitled "Site Selection Report - Peat Slurry Pumping and Pipeline Trials on a Canadian Peatland Site" which was submitted to the National Research Council of Canada and Energy, Mines and Resources Canada in January, 1986.

2.2 McLAUGHLIN BOG

221 LOCATION

The McLaughlin Bog is located about 5 km northeast of the Town of Gravenhurst, Ontario and about 200 km north of Toronto on Highway 11 about 200 m east of it. The Muskoka airport (general aviation) is located about 2 km northeast of the northern edge of the deposit.

The UTM co-ordinates of the approximate centre of the bog are: Zone 27, 6322 easting and 49788 northing. The geographical co-ordinates are: 44° 57' 20" N and 79° 19' 30" E. (Airphotos: 78-4466/94-253, and the 1:50,000 scale NTS topographical map no. 31D/14).

222 ACCESS

The deposit lies about 200 m east of Highway 11 and 100-200 m south of Reay Road. It is also surrounded by trails built for sports activities by the owner, as well as being skirted along its southern edge by the old Peterson Road. These roads offer good access to the northern, western and southwestern parts of the deposit.

223 OWNERSHIP

The entire deposit and some of the surrounding land is privately owned by Mr. F. McLaughlin of Gravenhurst, Ontario.

224 AREA AND SHAPE

This peatland is 93 ha in size including a 6 ha pond located along its eastern edge. It is estimated that about 50 ha of the deposit is readily usable for peat mining (see Figure 2-1).

The deposit is about 2 km long along its main axis in the north-south direction, and 1.7 km wide along its longest east-west axis. These long axes are measured into embayments extending along inlet and outlet streams stretching to the east and south of the main body of the deposit.

The main central body of the peatland is just over 1 km along its north-south axis and 700 m wide in the east-west direction.

225 TOPOGRAPHY AND DRAINAGE

The McLaughlin Bog lies at about 250-255 m above sea level and slopes gently from its northern end to the south. The surface of the deposit is quite flat showing a slightly raised central bog area surrounded by open fens and poor fens to the south, and treed bog to the west, and alder swamp to the north and northwest. The surrounding terrain rises quite gently from the bog up to about 265-270 m a.m.s.l. around its perimeter to the north, west and southwest. The eastern side of the bog is surrounded by slightly steeper land, rising steeply about 15 m above bog level.

The deposit is fed by one large stream from the northeast into its northeastern area. There are four other minor streams which are easily crossed on foot. These are located at the eastern, northern and western sides of the bog and drain only minor areas of the surrounding mineral terrain. The peatland is drained by a large creek, up to 10 m wide, from its southern extremity. This stream, straddled by a number of beaver dams (presently open), discharges eventually into Lake Muskoka at Muskoka Beach, about 4 km due west of the deposit. The length of the stream is about 10 km, including its meanders.

A levelling traverse from Monenco survey point B200N, towards the southeastern discharge channel (see Figure 2-2) indicated that there was a 1.0 m drop in elevation, allowing sufficient drainage to be carried out to firm the bog surface enough to carry equipment and personnel for the test. The relative elevation at B200N was set at 100 m. Above the first beaver dam the level of water was at 99.34 m and above the second beaver dam it was 99.13 m, at the time of levelling which was done after a heavy rainfall period.

Due to the flatness of the bog surface towards the discharge channel, it is possible to ensure that the water draining from the mining site has ample run-off time to allow sedimentation of whatever peat solids it may carry, before entering the discharge stream. In fact, this was the case during the actual test.

226 VEGETATION

The McLaughlin Bog is a transitional peatland between fen and bog type. The entire northern half of the deposit is characterized by a flat alder swamp, covered by a very dense growth of alders up to 3 m in height. This portion also has a high water table with numerous watery hollows with sedge and shrub vegetation.

From the centre towards the south, to about 150 m from the southern edge, the vegetation is characterized by bog-type vegetation composed chiefly of black spruce and tamarack about 4-5 m high at the most, with a 1-5% coverage. The understorey is composed of low shrubs (Chamaedaphne calyculata, Andromeda glaucophylla, Kalmia polifolia), some sedges (Carex pauciflora, C. trisperma), cottongrass (Eriophorum spissum) and sphagnum mosses (Sphagnum fuscum, S. magelanicum, S. angustifolium).

South of the treed low shrub area of the bog, there are areas of open low shrub bog and open graminoid fen. Along the edges, there is a narrow (5-10 m) zone of alder swamp which at the southwestern side widens up to 100-150 m.

227 PEAT THICKNESS AND PEAT TYPE

During November and December 1985, 20 survey sites were established on the southern half of the peatland - the location of the test site. A total of 19 peat samples were also extracted by Monenco from four survey points for moisture and ash content determinations. Figure 2-1 shows the location of the survey sites and gives the thickness of peat at each location.

At all of the sampling sites, the peat layer is underlain first by oozy peat and further below, by pure ooze. As this change is gradual, the exact line of change can only be determined at the sites where the ash content also was determined. The demarcation between the peat and ooze was set at a 25% ash content (dry weight basis). According to this, and visual determinations, the maximum peat thickness found was 4.1 m. The average thickness of peat was 3.3 m at the studied sites. At the sites where also the ash content was measured, the thickness of peat with less than 25% ash, varied from 2.0 to 3.5 m, averaging 2.9 m. The total depth of deposit exceeded the available auger length of 6 m at 10 sites. At each drilled site, peat was underlain by ooze and at the sites where the base was reached it was either sand or clay. Figure 2-3 gives profiles showing the peat thicknesses along the probed survey lines.

The peat type and the degree of humification (von Post) were determined at one reconnaissance site (see Table 2-1). At this site, the total thickness of peat was 3.0 m. It consisted of a 50 cm surficial layer of pure sphagnum peat with a degree of humification of H2. It was underlain by a 50 cm layer of sedge-sphagnum peat (H5), and another 50 cm layer of cottongrass-sedge-sphagnum peat (H5) with a very high content of fine fibers.

Below this layer, another 0.5 m of sedge-sphagnum peat (H6) was found, underlain by shrubby sedge-sphagnum peat (H5) and at the base by sphagnum-sedge peat (H7). Below the peat was a layer of ooze. The moisture content on a wet weight basis varied from 93.4% to 94.9% and the ash content from 2.0% to 14.6% on a dry weight basis.

In addition to the reconnaissance drilling, more probing was later done at the actual mining site to establish the peat thickness and peat types at this site. This additional drilling was done at 16 sites (See Figure 2-4); the peat thickness was determined at each of the 16 sites. At two sites (MS-1 and MS-2) also the entire profile was studied. At sites MS-2, MS-4 to MS-9, MS-11 and MS-12 core samples were obtained with a piston sampler for laboratory analysis.

The overall average thickness of peat at the 16 sites, including those close to the edge of the bog, was 2.1 m. Excluding the shallow peat near the edge the average thickness was 2.5 m.

Table 2-2 gives details of the peat types and the degree of humification at the mine site.

There is only a thin unhumified peat layer at the surface. Below that sphagnum dominated peats (sedge-sphagum) with a degree of humification of H7 are found to a depth of 1.5 m. Below this, quite pure sedge peats with some sphagum are dominant. Their degree of humification varies from H5 to H9. The basal soil is usually sand or silty sand with some clay. Quite commonly there is a layer of ooze below the peat. It varies in thickness from a few centimeters up to 5 metres.

228 ASH AND MOISTURE CONTENT ANALYSIS

.1 Reconnaissance Sites

A total of 30 peat samples from four separate sites were extracted to measure both the ash content (% of dry weight) and moisture content (% of wet weight). The results are given in Table 2-3.

The overall, average moisture content was 92.7% or within the normal range for a virgin bog (samples with an ash content higher than 25% excluded).

As the change from peat to ooze was very gradual, an attempt was made to subdivide the basal part of the samples into shorter intervals to define the point at which the ash content exceeded 25% (the limit for peat set by the U.S. Department of Energy as the maximum for fuel peat).

A reconnaissance site average ash content for the samples with less than 25% ash, was 7.7%. When the samples with ash content exceeding 10% were excluded, the average was 5.1%. The average ash content for the ooze was 44.7%. The ash contents are well within the levels acceptable for fuel peat.

.2 Mining Site

At the mining site, core samples for laboratory analysis were taken at eight sites (MS-2, MS-5 to MS-9 and MS-11 and 12). The cores were subdivided into a total of 36 sub-samples. Table 2-4 gives details of the basic analysis carried out on these samples in their virgin state (no special slurrying or other preparation except when required by the analytical procedures). The moisture and ash contents were determined for each individual sample. The moisture content varied from 83.6% to 94.5%. The overall average was 91.2% (of wet weight). The lower values were determined for the surficial peat and reflect the influence of the drainage of the site by a set of ditches dug during the winter of 1986.

The average ash content for all the individual samples taken from the planned mining site area was 11.69% (of dry weight); it varied from 3.08% to 42.60%. For the area actually excavated (see Figure 2-4), average ash was 10.9%. The higher values reflect the influence of ooze in the peat at the greater depths. It should be noted that in the case of the mining site samples, some sub-samples exceeding 25% ash were included, since it was considered that all material to the depth sampled would be included during actual mining. This tended to increase average ash content over the reconnaissance samples.

Other analyses was carried out on combined samples whereby the subsamples of each site were combined. Only the surficial sample at each site was left out since they were composed of highly fibrous and unhumified peat. Table 2-4 gives the results on the degree of decomposition and ash content measurements on the combined samples. The average ash content of 11.48% was still close to that determined from the individual samples. The degree of decomposition varied from 30.0% to 40.0%. On average it was 34.3%.

In addition to the above the wet bulk density, sulphur content, calorific value and the ash melting point were determined for two samples and pH (pH 4.3) for one sample. These values are within the normal limits for Canadian peat as can be seen in Table 2-4.

Table 2-5 gives the results of ultimate and sulphur analysis of combined samples representing the combination of samples MS-6/43-47 (=C) and MS-8/53-57 (=E). The table reveals that the results on ash, sulphur, carbon, nitrogen, hydrogen and oxygen contents fall within the common limits measured for fuel peat elsewhere in Canada as well as in Europe. Only the volatile matter content is lower than is commonly found for peat elsewhere.

229 STUMP CONTENT

The stump content of the peat was determined by probing at five points along the edge of the mine pit. At each site the probe was inserted into peat 10 times to the depth at which an obstruction was found but not exceeding 2 m. Each obstruction and its depth were recorded. From this data the stump content was calculated by using the Prohorov formula whereby the percentage of stumps of the volume of peat is calculated for 0-1 m and 1-2 m layers separately.

At the mine site the stump content of the surfacial layer 0-1 m was 2.6%. This is regarded high and would be a serious hindrance to dry mining. Wet mining, however, can still proceed without undue problems.

The stump content for the depth from 1 to 2 m was only 0.4%. In practice the stump contents of 1% or less are low, 1-2% are medium, 2-3% high. Anything over 3% is usually regarded too high and in most cases dry mining operations would not be considered if an option existed.

Figures 2-5 and 2-6 show exposed woody material at this mine site.

2210 WATER SUPPLY

A 6 ha pond, located on the eastern side of the bog containing an estimated 100,000 m^3 of water, was used as a source of water for the hydromonitors. Besides containing an adequate supply of water for the test, it also was located at a reasonable pumping distance from the mining area. There were no shortages of water during the test.

2211 SLURRY STORAGE FIELDS

The southwestern corner of the deposit, which is flat and has a shallow peat layer, was used for slurry storage with only minor work being required to prepare it for said purpose. A description of the preparatory work is in Part 3. This area is located adjacent to the mining area.

2212 SUPPORT FACILITIES

The test site was located only a few (5-8) kilometres from the Towns of Bracebridge and Gravenhurst. Support facilities such as repair and machine shops and sources of heavy equipment, fuel and parts located in these towns simplified the logistics of the test during operation.

TABLE 2-1

Reconnaissance Site, Sample Analysis Results, McLaughlin Bog

Sample No.	Sample Depth (cm)	Moisture Content (% wet weight)	Ash* Content (% dry weight)	von Post Formula	Remarks
1/85/GH	0-50	94.9	8.2 (7.1-9.1)	$SH_2B_4F_0R_0V_0$	
2/85/GH	50-100	93.4	3.0 (2.9-3.1)	$CSH_5B_4F_0R_2V_0$	
3/85/GH	100-150	94.3	2.3 (1.5-3.0)	$ErCSH_5B_4F_0R_2V_0$	
4/85/GH	150-200	94.2	2.0 (1.7-2.5)	$CSH_6B_3F_0R_2V_0$	
5/85/GH	200-250	94.2	2.4 (1.7-3.4)	$NCSH_5B_3F_0R_1V_0$	
6/85/GH	250-300	94.5	14.6 (10.8-16.9)	$SCH_7B_4F_0R_2V_0$	oozy peat
7/85/GH	300-350	94.4	53.5 (50.7-56.6)		ooze

NOTE: There was a lens of water at the 250-270 cm depth interval.

*Ash contents were measured for three sub-samples. The limits of variation in the brackets.

TABLE 2-2

Mine Site Peat Types and Degree of Humification; McLaughlin Bog

Depth (cm)	von Post Formula
	Site MS-1
0 - 10	C_4 S_6 H_2 B_3 F_0 R_0 V_0
10 - 80	C_4 S_6 H_2 B_3 F_0 R_0 V_0
80 - 150	C_4 S_6 H_2 B_3 F_2 R_2 V_0 (Er.)
150 - 190	S_2 C_8 H_6 B_3 F_1 R_3 V_0
190 - 250	S_1 C_9 H_5 B_3 F_1 R_3 V_0
250 - 300	S_1 C_9 H_9 B_3 F_0 R_{0-1} V_0
300 - 680	Ooze and Oozy clay
680	Sand
	Site MS-3
0 - 10	C_4 S_6 H_2 B_3 F_0 R_0 V_0
10 - 80	C_4 S_6 H_7 B_3 F_0 R_0 V_0
80 - 150	C_4 S_6 H_7 B_3 F_2 R_2 V_0
150 - 250	S_2 C_8 H_6 B_3 F_1 R_3 V_0
250 - 300	Oozy peat
300 - 800	Ooze and Clay
800	Clay and Sand

TABLE 2-3

Peat Ash and Moisture Content Analysis, Reconnaissance Sites; McLaughlin Bog

Sampling Points	Sample No.	Depth Interval (cm)	Ash Content (% dry weight)	Moisture Content (% wet weight)	Remarks
Reconnaissance Sites (cf.Figure 1)	1	0-50	8.2	94.9	
	2	50-100	3.0	93.4	
	3	100-150	2.3	94.3	
	4	150-200	2.0	94.2	
	5	200-250	2.4	94.2	
	6	250-300	14.6	94.5	oozy peat
	7	300-350	53.5	94.4	ooze
B200N + 150W	10	0-50	5.0	94.1	
	11	50-100	6.4	89.0	
	12	100-150	6.4	90.7	
	13	150-200	6.6	90.9	
	14	200-250	5.4	92.3	
	15	250-300	5.0	93.2	
	16	300-320	6.3	92.0	
	17	320-350	23.5	91.7	oozy peat
B100N + 100E	18	0-50	4.0	94.2	
	19	50-100	8.2	88.7	
	20	100-150	7.1	91.2	
	21	150-200	21.3	91.8	oozy peat
	22	200-250	29.8	90.2	ooze
	23	260-300	45.4	89.8	ooze
	24	300-350	47.2	89.9	ooze
B100N + 300E	25	0-50	9.3	93.2	
	26	50-100	4.2	91.6	
	27	100-150	3.1	93.0	
	28	150-200	3.1	93.1	
	29	200-250	4.8	95.0	
	30	250-300	22.2	92.6	oozy peat
	31	300-320	39.4	91.4	ooze
	32	320-350	52.7	89.6	ooze
			*AVG. 7.7%	*AVG. 92.7%	

NOTE: *Average excludes the samples with more than 25% ash content.

TABLE 2-4
Analysis of Mine Site Peat, McLaughlin Bog

Site No.	Sample No.	Depth (cm)	Moisture Content (% of Wet Weight)	Ash Content (% of Dry Weight)	Analysis done on combined samples.					
					Degree of Decomposition %	Ash Content	Bulk Density Wet g/cm^3	pH	Calorific Value cal/g	Ash Fusion °C
MS-2	33	0-30	90.9	9.84	Avg. 31.3	9.5				
	34	30-80	92.3	3.91						
	35	80-150	94.2	2.11						
	36	150-200	93.7	5.72						
	37	200-250	93.3	25.7						
MS-5	38	0-30	89.0	9.73	Avg. 33.3	10.8				
	39	30-80	92.0	4.46						
	40	80-150	93.2	2.89						
	41	150-200	94.5	5.78						
	42	200-250	93.7	30.8						
MS-6	43	0-30	83.6	6.95	Avg. 33.8	15.28	1.055	4.3	3985	1350
	44	30-80	90.2	3.22						
	45	80-150	93.8	3.08						
	46	150-200	92.4	21.1						
	47	200-250	90.5	42.6						
MS-7	48	0-30	87.7	7.77	Avg. 40.0	12.3				
	49	30-80	88.2	5.33						
	50	80-150	92.8	7.11						
	51	150-200	93.2	9.52						
	52	200-250	93.1	16.2						
MS-8	53	0-30	87.2	8.76	Avg. 30.8	15.90	1.039		3834	1320-1350
	54	30-80	90.1	4.74						
	55	80-150	94.0	3.10						
	56	150-200	94.2	17.4						
	57	200-230	90.9	41.2						
MS-9	58	0-30	86.7	11.4	Avg. 41.8	8.3				
	59	30-80	92.0	9.33						
	60	80-150	92.9	4.96						
	61	150-180	92.4	5.81						
MS-11	62	0-30	86.1	12.9	Avg. 34.3	7.1				
	64	30-80	85.2	8.21						
	68	80-130	92.8	5.81						
MS-12	65	0-30	91.5	10.9	Avg. 30.0	16.5				
	66	30-80	89.6	7.38						
	67	80-150	92.7	6.92						
	68	150-175	90.8	38.1						
Averages			91.2	11.69	34.3	11.48				

TABLE 2-5

Ultimate and Sulphur Analysis of Mine Site Peat Samples, McLaughlin Bog

Sample	Composite "C" Wet	Composite "C" Dry	Composite "E" Wet	Composite "E" Dry
Moisture %	89.27		91.18	
Volatile Matter %	2.20	20.50	1.49	16.89
Ash %	1.64	15.28	1.34	15.19
Sulphur %	0.03	0.28	0.03	0.34
Carbon %	5.02	46.78	3.93	44.56
Nitrogen %	0.22	2.05	0.19	2.15
Hydrogen %	0.59	5.50	0.49	5.55
Oxygen (by difference) %	3.23	30.11	2.84	32.21

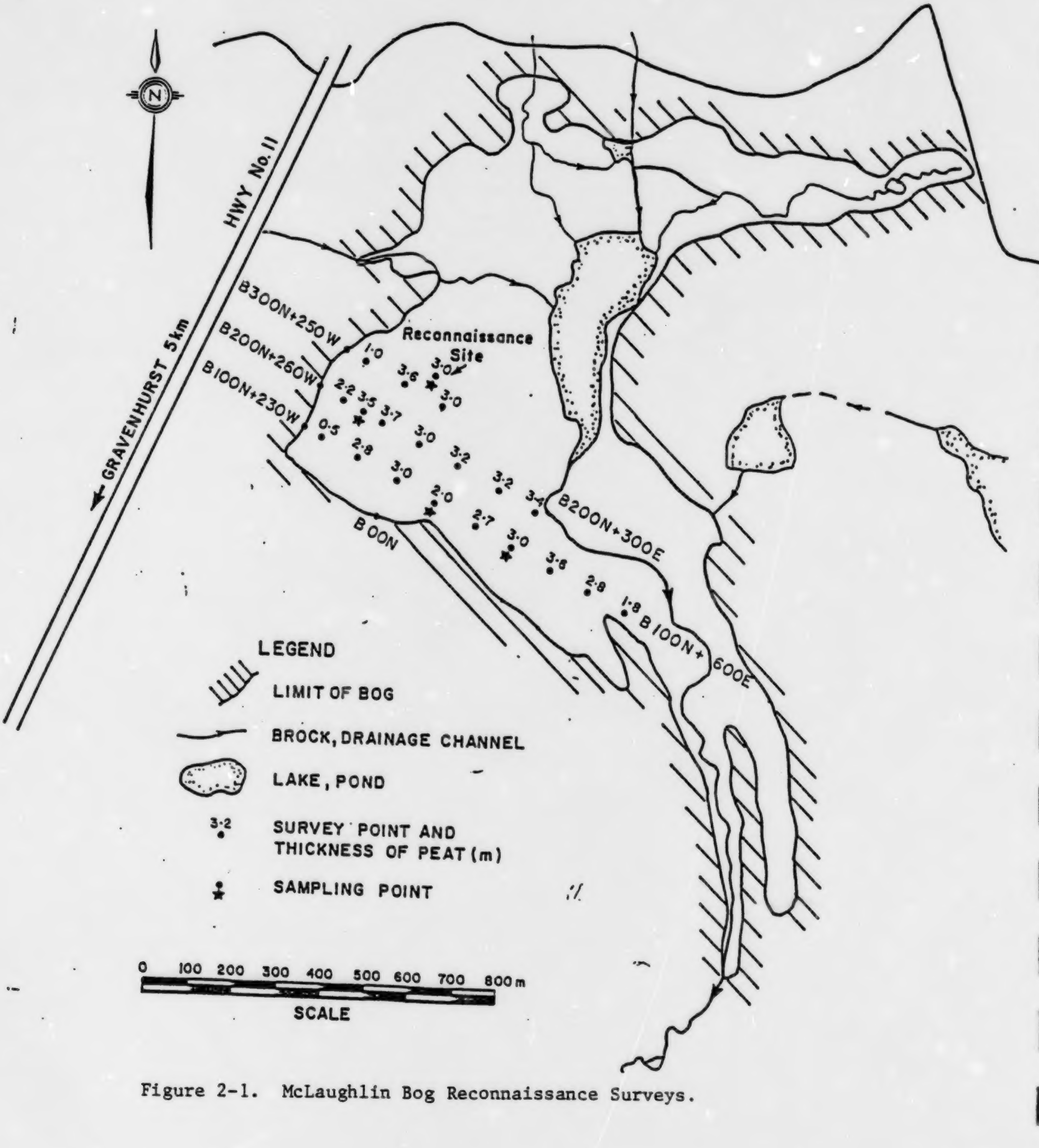
N
HWY No.11
GRAVENHURST 5km
B300N+250W
B200N+260W
B100N+230W
B00N
B200N+300E
B100N+600E
Reconnaissance Site
1·0
3·6
3·0
3·0
2·2
3·5
3·7
0·5
2·8
3·0
3·2
3·0
3·2
3·4
2·0
2·7
3·0
3·6
2·8
1·8
LEGEND
LIMIT OF BOG
BROCK, DRAINAGE CHANNEL
LAKE, POND
3·2
SURVEY POINT AND THICKNESS OF PEAT (m)
SAMPLING POINT
0 100 200 300 400 500 600 700 800 m
SCALE

Figure 2-1. McLaughlin Bog Reconnaissance Surveys.

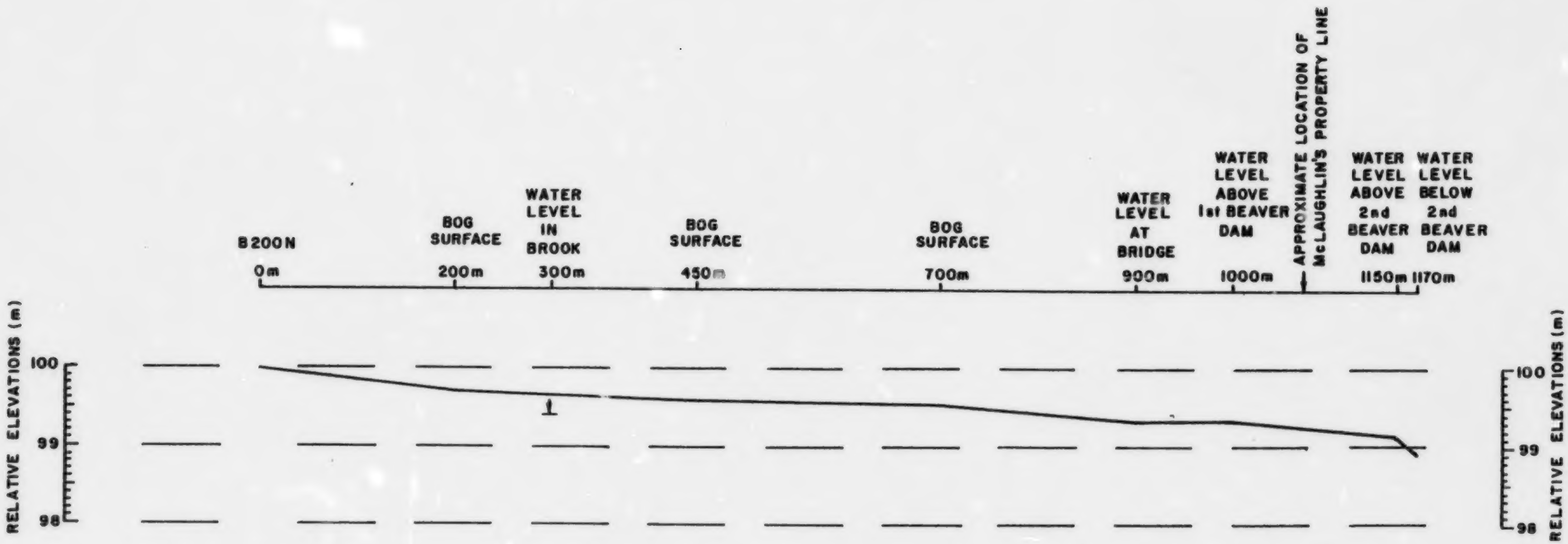

Figure 2-2. Reconnaissance Levelling, McLaughlin Bog, Gravenhurst, Ontario

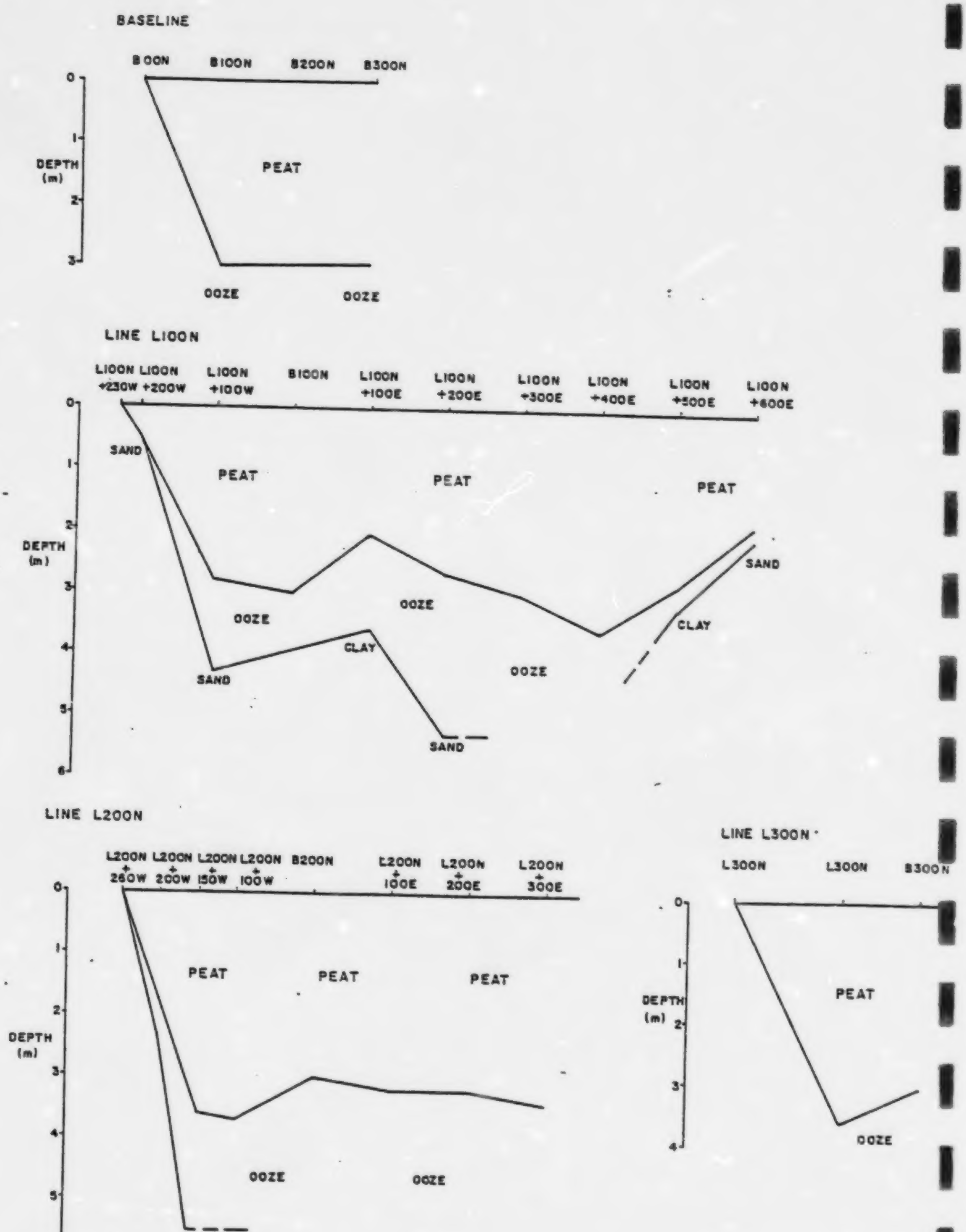

Figure 2-3. McLaughlin Bog Peat Profiles.

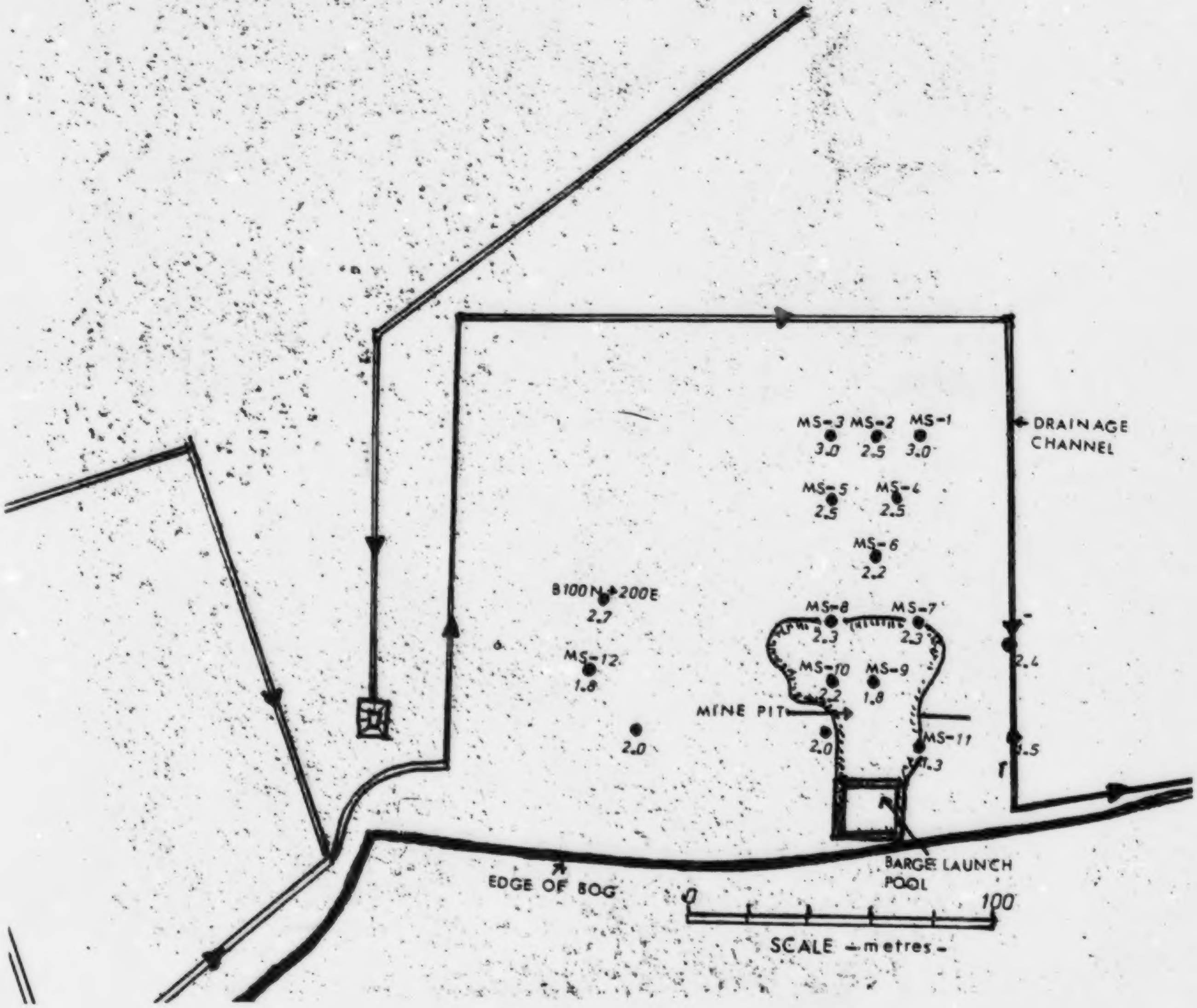
MS-3
3.0
MS-2
2.5
MS-1
3.0
DRAINAGE CHANNEL
MS-5
2.5
MS-4
2.5
MS-6
2.2
B100N+200E
2.7
MS-8
2.3
MS-7
2.3
2.4
MS-12
1.8
MS-10
2.2
MS-9
1.8
MINE PIT
2.0
2.0
MS-11
1.3
.5
EDGE OF BOG
BARGE LAUNCH POOL
0
100
SCALE -metres-

Figure 2-4: Wet Mining Site and Sample Locations.

MS-1 = Sample number
● 2.0 = Thickness of peat (m)

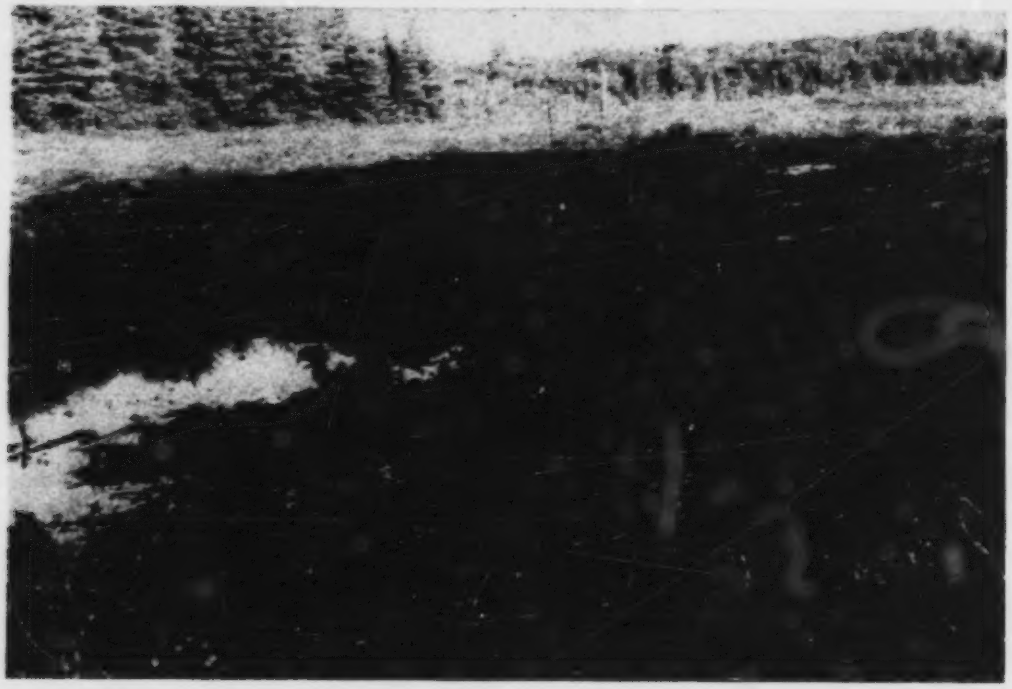

Figure 2-5. A View of Exposed Peat Showing Stumps and Stems of Dead Trees Buried in Peat.

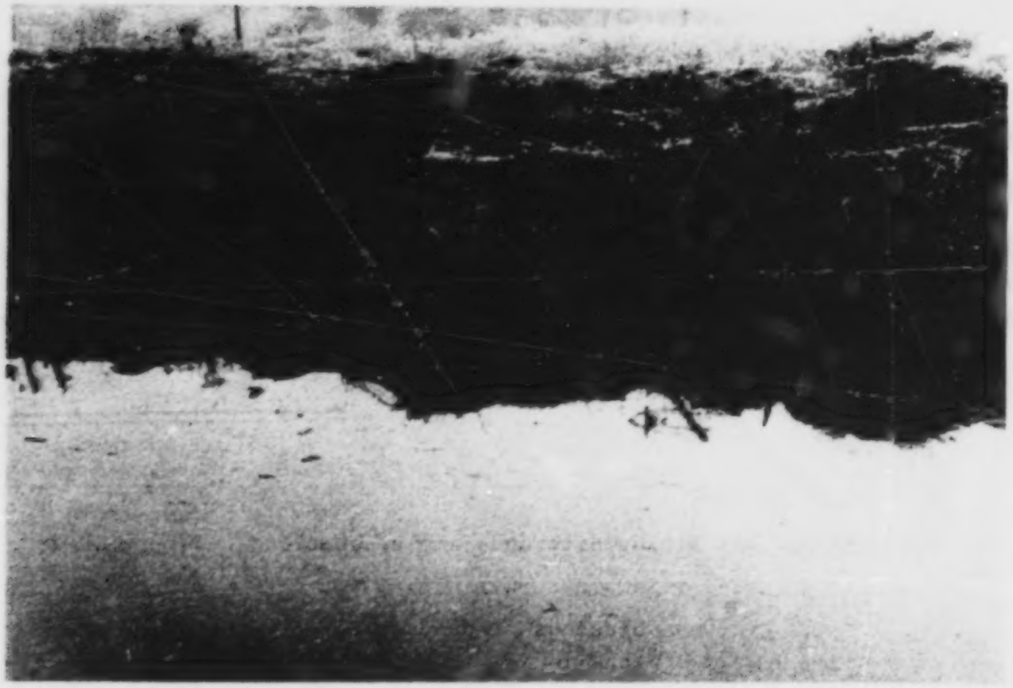

Figure 2-6. Ibid

PART 3

SITE PREPARATION

PART 3 - SITE PREPARATION

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3.1 MINE SITE LOCATION

The location of the actual mine site was based on the information from the bog survey, particularly peat thickness as well as access to the location, availability of water for operation of the hydromonitors, reasonably good drainability of the area and the absence of dense vegetation (trees) at the mine site.

The access was good to the western and southern parts of the deposit from the old Peterson road that skirts the bog. Some road improvement was needed to enable hauling of heavy equipment to the site.

The thickness of peat was greatest in the middle of the bog. However, access to this part would have required expense and time consuming road construction on the bog. The thickness of peat was considered adequate along the southern portion of the deposits where the actual excavation site was selected (Figure 3-1). The slurry ponds were located towards the western part of the bog (Figure 3-1) which was slightly higher than the final mine pit location and allowed better drainage of the slurry ponds. The southern half of the deposit was better suited for the mining test than the northern half since the vegetation in the southern half was sparser and composed of low shrubs and open sedge covered fen areas. The northern half of the bog had quite a dense alder and black spruce cover that would have added to the clearing costs.

The mine site (Figure 3-1) was located where access to the bog was good (minimum road construction and clearing), the peat thick enough and the source of extra water close by. Also, there was no need to remove any surface vegetation from the excavation site as it was mainly composed of only low shrubs and sedges. The site was high enough to drain it sufficiently for access by heavy equipment required to lay out the slurry pipeline and to control the surface water.

3.2 DRAINAGE DITCHES

A series of drainage ditches were excavated to prepare the site for the test. In all, close to 2,800 m of channels were dug. The objectives of the ditching were to drain both the free surface water as well as the spring meltwater from the test site and to improve the trafficability of the peatland surface in the test area.

The main drainage ditch (560 m long) measuring 2 m in depth and 2.5 m wide was excavated to link the ditches of the test site (the mining area and slurry storage area) to the creek draining the deposit (see Figures 3-1 to 3-3). Because of numerous meanders in the creek, an additional 250 m ditch was dug southwards to the point where the creek and the McLaughlin property line intersect (see Figure 3-1). This ditch was originally 1.2 m in depth and 1.8 m in width.

Portions of a beaver dam situated across the creek south of the bridge was also removed to improve drainage. A perimeter ditch was dug around the mining area (see Figure 3-1). This ditch, which discharged into the main drainage channel, was about 1.5 m deep and 2.1 m wide (see Figure 3-4). The spoil was placed on the inside of the mining area creating a berm around its entire perimeter ensuring that no slurry would escape from the mining area into the creek during the test. The perimeter ditch was to intercept any flow of water from the surrounding peatland into the mining area.

3.3 SLURRY STORAGE FIELDS

Three slurry storage fields were prepared for the test. A perimeter ditch, similar in size to the one surrounding the mining area, was excavated (see Figure 3-1). Again, all of the spoil was used to construct a berm enclosing the entire drying field (see Figure 3-5). To ensure that enough spoil was available to construct the berms along the ditches separating the drying fields, the ditch widths were increased to about 2.8 m, on average, in comparison with 2.1 m for the ditches skirting the outer edges of the storage fields (Figure 3-6). In all, about 1,450 m of ditches were excavated. Approximately 385 m of these were 2.8 m and the rest 2.1 m wide.

All of the ditching and pool excavation (described in the following section) was done by 9½ tonne excavator outfitted with a special set of tracks, designed for traversing peatlands. A special contoured 650 litre bucket was used to maintain the optimum shape of the ditches. (Note the bucket shape in Figure 3-5).

During the summer season the vegetation on two easternmost slurry fields was mulched with a tractor operated horizontal chipper outfitted with chains to mulch the vegetation. This procedure ensured a clean and relatively smooth surface for the slurry. Figures 3-8 and 309 shows the equipment used to mulch the vegetation and the prepared slurry pond. Figures 3-11 and 3-12 are aerial views of the entire site. Figure 3-12 contains an attempted excavation of a water reservoir, abandoned due to inflow of ooze.

3.4 WATER SUPPLY CHANNEL AND POOL

A water supply channel, to supply the hydromonitors with a sufficient quantity of water, was excavated to divert water from the main creek to a 10 by 12 m and 4 m deep pool situated adjacent to the west side of the mining area. The channel linking the pool and creek was dug 2.5 m deep and 3.5 m wide at the top (see Figure 3-7). It was made large enough for a flowrate of 0.76 m^3/s and at a flow velocity of 0.2 m/s, and not to exceed a velocity of 0.4 m/s at which erosion of the channel walls was expected to occur. The water supply channel was about 295 m long.

3.5 BARGE LAUNCHING POOL

To facilitate the assembly and launching of the barge, on which the peat slurry pump and hydromonitors were mounted, a pool measuring 20 x 20 metres square was excavated close to the southeastern corner of the mining area. Its depth varied from 2.5 to 3.0 m (see Figure 3-10).

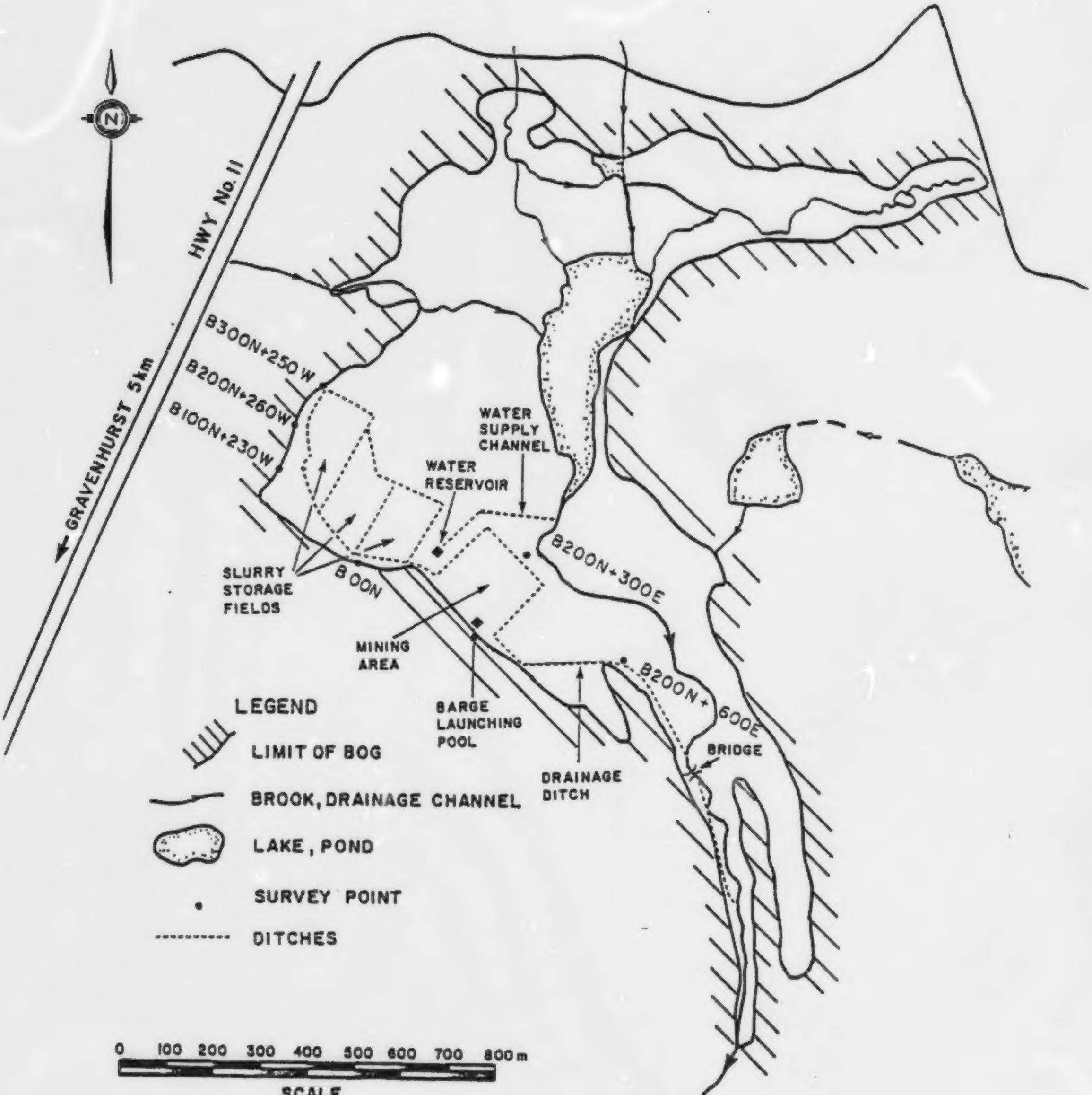
N
HWY No.11
GRAVENHURST 5km
B300N+250W
B200N+260W
B100N+230W
B00N
WATER SUPPLY CHANNEL
WATER RESERVOIR
SLURRY STORAGE FIELDS
MINING AREA
BARGE LAUNCHING POOL
DRAINAGE DITCH
B200N+300E
B200N+600E
BRIDGE
LEGEND
LIMIT OF BOG
BROOK, DRAINAGE CHANNEL
LAKE, POND
SURVEY POINT
DITCHES
0 100 200 300 400 500 600 700 800m
SCALE

Figure 3-1. Approximate location of ditches and pools, McLaughlin Bog.

Figure 3-2. Main Drainage Ditch Excavation

Figure 3-3. Main Drainage Ditch Excavation
- Depth 2 m, Width 2.5 m (at top)

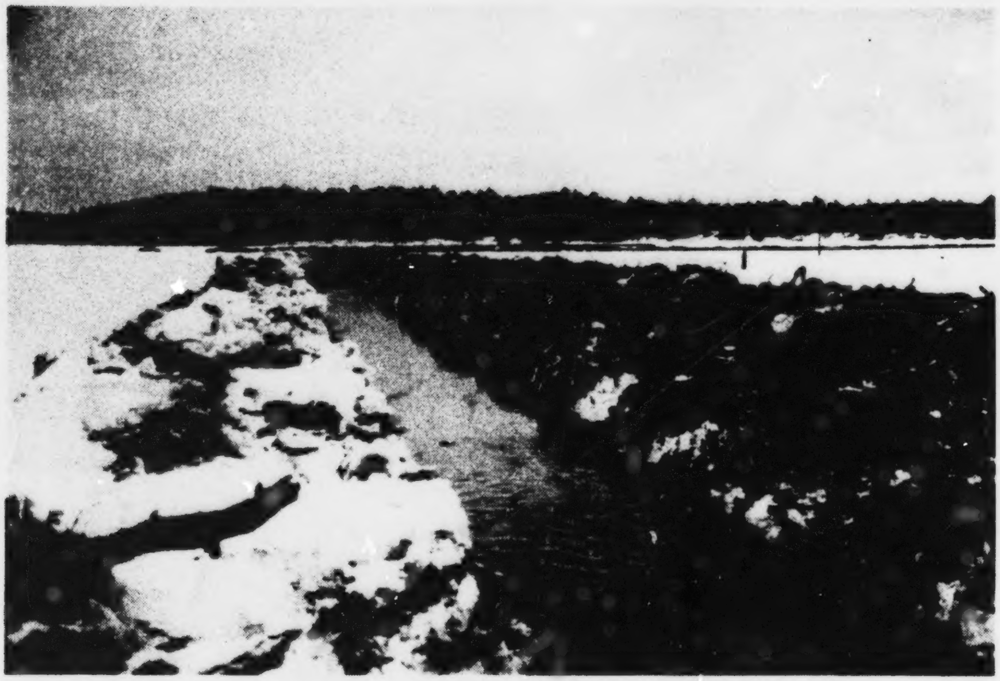

Figure 3-4. Perimeter Ditch Along the West Side of the Mining Area

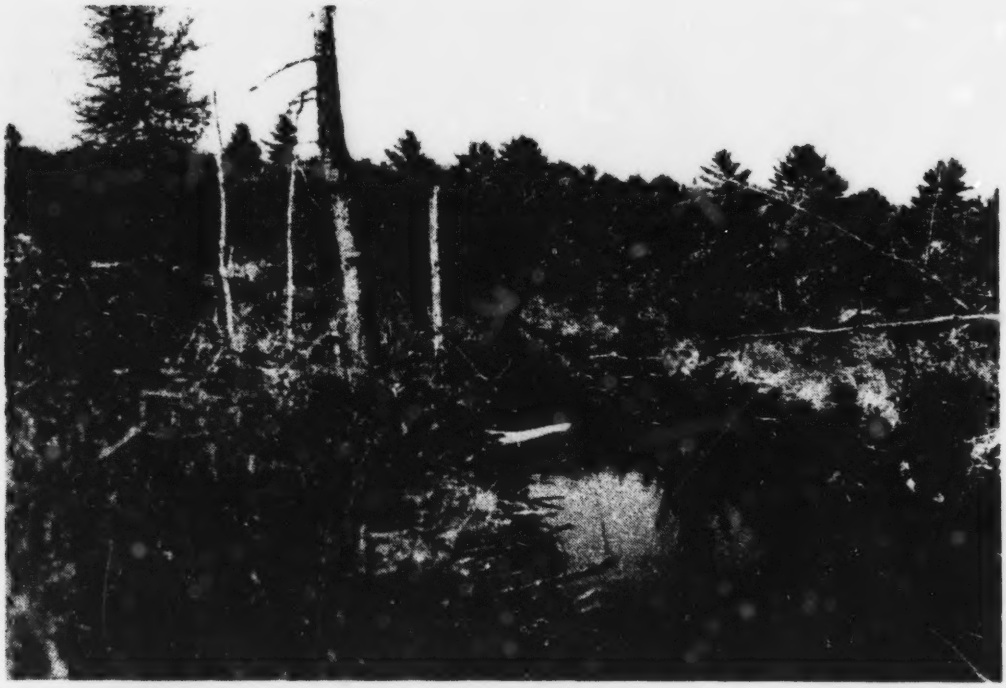

Figure 3-5. Ditch Between Slurry Ponds.

Figure 3-6. Slurry Storage Field Preparation

Figure 3-7. Channel Linking the Pool and Creek
- Depth 2.5 m, Width 3.5 m (at top)

Figure 3-8. Mulching the Vegetation on Slurry Pond.

Figure 3-9. Cleared Slurry Pond

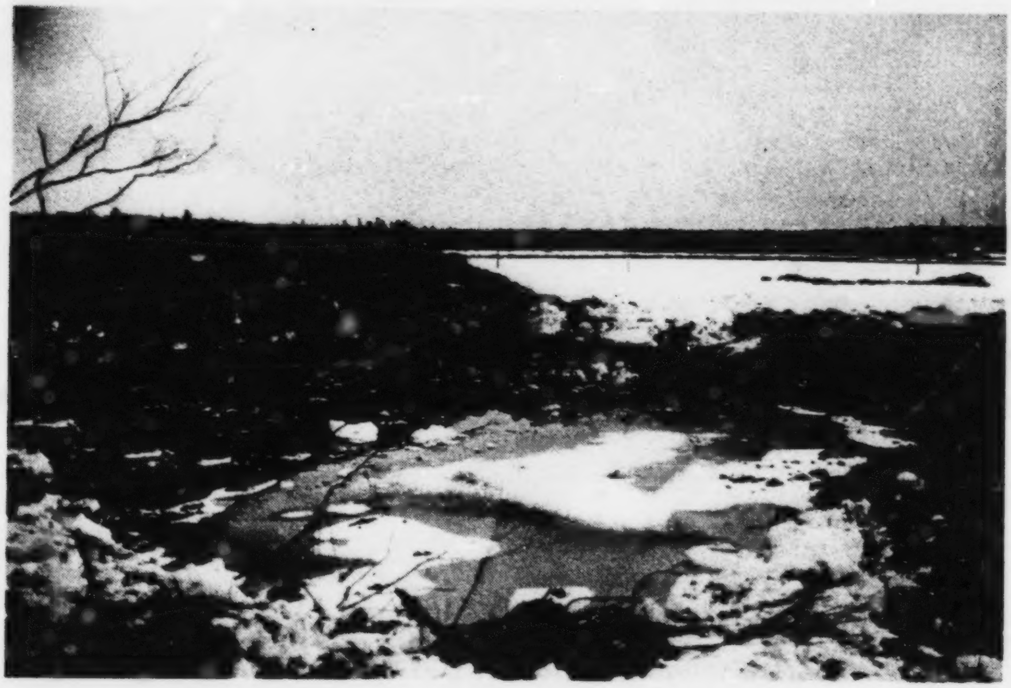

Figure 3-10. Barge Launching Pool

PART 4 - EQUIPMENT SELECTION, SET UP, PEAT EXCAVATION

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4.1 EQUIPMENT SELECTION

The anticipated peat slurry pump capacity operating range and slurry solids content, based on preliminary calculations of water addition for slurrying and the in situ peat moisture contents measured, and previous "run-in" experience in the 1985 peat slurry pumping work (Reference 2) largely determined the scale of operation for the tests and the main pieces of equipment required for the slurry transport and water supply systems. The design of the peat slurry pumping and water supply systems were largely based on the previous USSR experience with the "hydropeat" mining method, however, USSR practice used hydromonitors operated manually from various positions on the bog surface directing a water flow into an advancing pit. At the deep end of this half-funnel shaped pit was positioned the peat slurry pump, supported from a rail-mounted crane platform which retreated as the mining pit advanced. The "hydropeat" system operated from the surface of the bog, the steel rails being supported by pilings.

In Canada, peat has been excavated commercially in slurry form previously, at two locations of note - the former Western Peat Moss Ltd. operation south of Vancouver, B.C. and the Hood Mfg. Enterprises Ltd. facility near Edmonton, Alberta. The Western Peat Moss operation used a hoverbarge to support a clamshell excavator, root separator, slurry pump and other equipment and the Hood facility used a 20' x 40' x 4' barge to support similar equipment. Both extraction systems prepared a peat slurry of about 1% (by weight) solids concentration. Both barges operated in a floating position in a pond, and well off the bottom.

For the current project, it was decided to mount the hydromonitors, high pressure pumps and peat slurry pump/macerator on a barge (actually a scow with raked ends, see Figure 4-1) which would be placed in the operating pit and float only intermittently when required during moves. To ensure an exposed mining face for the hydromonitors to act upon, it was planned that the slurry would be kept at a minimum level and that the barge would be only partially in a floating position, particularly the end of the barge advancing into the pit face where the peat slurry pump/macerator was operating. It was unknown whether this technique would prove successful or incur problems, since there was no previous information that it had been tried before.

Other equipment (such as the diesel-electric generator electric motor, Lannen S-10 bog tractor, 4WD M-F farm tractor, crane, bulldozer, service vehicles, etc.) was selected to match the requirements of the main slurry pumping and water supply equipment and to suit the peatland conditions present, as well as to prepare access to the site. All equipment, except the peat slurry pump/macerator which was fabricated in 1985 according to Monenco design specifications, and some modifications to the scow, were basically "off-the-shelf" items. Table 4-1 is a list of the main pieces of equipment used to conduct the test.

4.2 GENERAL ARRANGEMENT

Figure 4-2 "Site Layout" shows the general arrangement of equipment at the site to carry out the various pumping tests. It shows a portion of the bog outline (southern edge), the layout of the drying fields (slurry storage) and mining area, enclosed by berms made from peat spoil material taken from the surrounding drainage channels, the location of the peat slurry pipeline, water pipeline and pump station, barge, slurry pump and power supply. The slurry storage fields were located at the northwest end of the bog to take maximum advantage of the elevation drop across the peatland, since it was not possible to control water levels in the peatland beyond the owner's property boundary. The mining area was located adjacent to the slurry fields with the actual mining pit located to take advantage of the maximum depth of peat as close to the southern edge of the bog as possible, as well as the existing topographical and surface cover conditions to enable equipment access onto the bog.

Timber bridges were located as required to gain access onto the drying fields and other areas of the bog with equipment for surface clearing, set up of the water pumping station, pipelines, etc. Decant boxes were installed in drying fields 1 and 2 to decant overflow water or recycle water to the water supply reservoir, if necessary. Figure 4-2 also shows the location of the pool prepared to accommodate launching and assembly and placement of equipment onto the scow. Due to budget constraints, there was only sufficient time to excavate peat from within the outline of the mining pit, as shown in Figure 4-2.

Varying lengths (20 to 100 m) of 300 mm (12 inch) diameter polyethylene pipe (series 60) were fusion welded together on site and towed by tractor onto the bog for assembly in place. Figure 4-2 shows the layout of the peat slurry pipeline as used for Test 2, runs 5, 6, 7 and water Test No. 2 and the location of the main water supply pipeline (also prepared from polyethylene pipe) and the main water pumping station. In fact, two separate pumping/pipeline systems existed - the water supply system and the peat slurry system, which interacted at the point of excavation of the peat, where the water at high pressure from the hydromonitors was used to break up the peat mining face and prepare the peat slurry.

4.3 MINING PLAN

This section mainly describes the mining related aspects of the test procedure; the pumping test procedure is described in detail in Section 5.1. The main objectives of the mining demonstration were:

- to determine the operating characteristics of the peat slurry pump/macerator as a mining tool;
- to assess the effectiveness of the scow-mounted "hydropeat" mining system operating in a typical Canadian peatland with a relatively high stump content (2.6%); and
- to prepare a suitable peat slurry for the pumping and pipline tests.

After study and previous experience from the 1985 "run-in" peat slurry pumping project, it was decided to test the use of a scow as a mounting platform for the extraction equipment during operation. A scow was expected to provide the required mobility for travel of the equipment set throughout the peat bog during peat extraction, to ensure continuity of peat slurry for further downstream processing needs, as expected in a commercial operation.

Peat slurry pumping was carried out at full industrial scale, with testing planned at capacities from 340 to 505 m^3/hr. (1500 to 4000 USgpm approximately), under varying pumping conditions. The site was considered a virgin peatland with minimal drainage of the in-situ peat prior to testing, basically only control and removal of surface water from the mine area to allow passage of the modified, low ground pressure tractor. Stump content was considered high (2.6%) and representative of difficult peatland excavation conditions.

Peat slurry was formed from the impact of water from the high pressure water jets which broke up the in situ peat at the excavation site; it flowed into the sump area between the barge and the active mining face where the peat slurry pump was located. Peat slurry, stumps, roots, rootlets, shrubs, mosses, grasses, etc. entered the sump area where the larger material (stumps, large roots) was deflected by the external propeller on the bottom of the pump. Peat, peat slurry, woody remnants and smaller debris entering the pump passed through a macerating chamber where a proper consistency of slurry was prepared to facilitate pumping. Delivery of the macerated peat slurry through the pipeline to the storage reservoir constituted the last step in the process.

431 SEQUENCE OF ACTIVITES

More specifically the following sequence of activities were carried out:

- placement of depth markers throughout the mining area for mining depth control;

- commencement of water jetting from the launching pool position and excavation of peat to the north toward the area of thicker peat, where it was planned to start the actual pumping tests. However, some "preliminary" tests were carried out in the general "launching pool" area;

- re-positioning of the scow further north toward the centre of the bog and commencement of water jetting and actual peat slurry pumping tests;

- pump peat slurry to field No. 2 (middle field), field No. 1 to be used for a shorter pipeline length. Field No. 2 was utilized since it represented average pipeline length conditions, and allowed overflow water to be decanted into field No. 1, if settling in field No. 2 proved too slow or if recycle water was required due to low water supply (these situations did not occur).

- carry out data monitoring and sampling of pump, pipeline and peat slurry;

- as peat excavation is completed within the effective range of the hydromonitors, then re-position the scow assembly further north into the peatland by partially flooding the workings to allow the scow to float to a new position, using the spud winch and cable attached to a stationary tractor on the bog surface (acting as a "deadman");

- disconnect and re-connect the water supply and peat slurry pipelines, as required;

- commence excavation at the new scow position, excavating peat over the full peat depth, attempting to leave about ½ m or so of peat on the bottom to avoid contamination of the peat with mineral matter. Carry out data monitoring and sampling of pump, pipeline and peat slurry;

- carry out modifications to the pump or pipeline as required by the various test configurations; and

- repetition of the last four steps as required until the required number of "tests" and "runs" have been carried out.

432 WATER SUPPLY/HYDROMONITOR OPERATION

Water from the water reservoir was pumped through the 300 mm (12 inch) polyethylene pipe to the scow where it entered a "Y" connection in the pipe and the flow was split to the two high pressure water pumps. The inlet pressure was typically about 30 psi, and outlet pressure typically about 200 psi. The high pressure water flowed through a flexible 152 mm (6 inch) hose to the hydromonitor, where it was discharged at about 1240 kPa (180 psi).

Since the scow had a fixed location during a "run", water from the hydromonitors had to travel an increasing distance with time during the "run". This affected the "cutting" ability of the jets and required an increased distance of slurry flow to the peat slurry pump, therefore the scow was re-positioned periodically closer to the mining face. The size (volume) of the slurry pond (sump) in front of the scow, where the peat slurry pump operated, particularly affected the relationship between peat slurry solids concentration and hydromonitor flowrate. In the larger slurry pond, the hydromonitor flowrate took longer (about one hour) to affect the slurry concentration. As well, the larger peat particles tended to settle out. With a small slurry pond (sump), the hydromonitor water flowrate affected slurry solids concentration almost immediately. To prevent clogging of the slurry pump intake and to keep the larger particles flowing to the slurry pump, the hydromonitors were used to agitate the slurry in the vicinity of the slurry pump from time to time, and this tended to cause fluctuations in the slurry concentration and a scattering of data and introduced error in the relationship shown between peat slurry solids concentration and total hydromonitor flowrate.

Appendix B contains data on the waste supply system including discharge pressures and flowrates. A regression analysis was carried out, using the data from all the runs, to develop a relationship between total hydromonitor flow rate versus slurry flow rate versus slurry solids concentration. The results are shown graphically on Figure 4-3; with increasing slurry flowrate the amount of water addition from the hydromonitors increases, which is less at higher solids concentration slurry than at low solids concentration.

4.4 MINING RESULTS

Section 3.1 of the report describes the reasons for selecting the particular mining site area of the bog, including access onto the bog, surface cover, depth of peat, distance from the bog edge to a relatively thick area of peat, positioning relative to water supply, location of slurry storage areas, possibility of recycling water, elevation gradient, etc. The depth of peat encountered during the mining test (up to 2.3 m) appears to be about the minimum which should be considered for the "hydropeat" type of mining system; it is best suited for the deepest peat deposits. The USSR design minimum for use of a similar system was 1.5 m depth, although peat thickness was usually kept to 2.5 m minimum for economic reasons. With peat layers less than 2 m, it is too easy for the hydromonitors to penetrate through the peat into the mineral soil, resulting in a relatively high ash content peat slurry. This could be minimized through automation of the hydromonitor sweep angles, but occasionally it is necessary to use the hydromonitors to promote slurry flow to the sump. With a peat layer of less than 2 m, re-positioning (equipment moves) would increasingly reduce equipment availability for peat production.

Table 4-2 summarizes the basic peat production information as obtained from the various 'tests' and 'runs', averaged over the total "run" time. Higher solids concentrations and lower ash contents occurred on various specific runs, as shown in the data sheets (Appendix A). During Test 1, run 3, a solids concentration of 3.7% (by weight) peat slurry at 22.5% ash was achieved. Higher solids concentrations were obtained (6.3%) but at much higher ash content. An ash content of 25% (of dry weight) is considered maximum for fuel peat.

Lower ash content in the peat slurry is expected possible at other similar deposits. The actual mining site was somewhat unique, since it was underlain by an ooze layer which proved difficult to contend with. For example, a number of alternative locations were unsuccessfully excavated for a water supply reservoir, since flow of the ooze layer into the reservoir was experienced while excavating was taking place. The desired depth of water reservoir was never achieved and the water supply intake strainer was merely placed in the main water supply channel, which proved adequate during the tests. At the mining test site, the ooze layer was very easily penetrated and was considered responsible for the relatively high ash content levels experienced during the various tests. Selecting a similar deposit with more favourable underlying soil characteristics can be expected to yield lower ash levels in the peat slurry. As well, there was not a clear demarcation between the peat and ooze, rather the bottom peat was a mixture of peat and ooze with high ash content.

The mining area was considered as "undrained", since only preliminary drainage had occurred, sufficient only to dry the surface layer a few percent, largely through control of surface waters by the ditches. The top 0 to 0.5 m was a heavy surface mat of roots and shrubs which allowed good surface trafficability. The deposit had a high stump content (2.6%); in the USSR over 1.5% is classified as high and over 3.0% very high. It was considered important to evaluate the mining system performance in a bog with a high stump content, although considerable additional water was required to wash peat free of stumps and stumps absorb the impact of the water jets.

The scow-mounted "hydropeat" equipment operated well in an "undrained" peatland environment. It is generally compact, which could be improved upon by using electric drive motors for the high pressure pumps and winch mechanisms. The scow balanced and floated well in water with about 16-18 inches of draft with full load. Moves were quite restricted due to the pipeline connections and the power supply cable but considering the tests allowed a relatively short period of operation (three moves), it is expected this aspect could be considerably improved for a commercial operation.

In the USSR, mining was carried out intermittently; about once every hour mining was halted to clear out stumps, roots and other debris. During the current program, no interruptions occurred due to problems with stumps, although it may have been necessary to do so over a longer test period. In the USSR, the equipment was all mounted on the bog surface and a grappling crane was used to stack stumps to the side for berm construction.

A modified Russian method for slurry storage reservoir berm construction was used. After excavating the ditch, peat and some underlying material was set to the side to form berms. Berms constructed during the winter stood throughout spring and summer and effectively contained the peat slurry. Decant boxes which were installed for environmental safety reasons, and possible water recycle, were unused. Peat slurry very quickly filtered through the top 30 to 50 cm of unhumified peat to the layer of humified peat and flowed sheet-like into the surrounding ditches. The discharge water was quite dark with peat sediment; the ditches returned to normal water coloration after a few days. Although several agencies were contacted, none were able to be present to monitor and sample water quality during the tests.

During surface preparation activities, the surface material within the slurry storage reservoirs was mulched and spread to form a relatively flat surface. Up to 30-35 cm (12-14 inches) of slurry was pumped into field No. 2 which decreased to about 10 cm (4 inches) in 4-5 days. Visual inspection showed the peat slurry to be of good consistency - it readily could be formed by hand into cohesive sods, all material having obviously been well macerated. The surface appeared well suited to support later harvesting equipment.

Since it was the intent of the project to develop a wet peat harvesting system which prepares peat in slurry form for further downstream processing, it may be required to increase slurry solids concentration by settling methods, prior to entry into a process plant. An earlier Monenco project (Reference 3) described the "Monenco Settling Method" based on study and experimentation carried out previously in the USSR.

Figures 4-3 to 4-10 inclusive are photos of various aspects of the test.

TABLE 4-1

List of Equipment Used in Test

---

1. Scow, 2-section, each section 12' x 50' x 4', raked ends, c/w deck beams for space between sections, if required.

2. Skid mounted double drum hoist together with 46 foot boom, powered by diesel engine.

3. 2 spuds, 20' long, 6 in diameter c/w spud winch, diesel powered.

4. Peat slurry pump/macerator 14x8x21 PW-MV Pump, manufactured by Allis-Chalmers according to Monenco specification (approx. 2000 to 4000 USgpm capacity range).

5. Polyethylene pipe, 12" diameter, series 60, 900 m (3000 ft), fusion welded in 10 m to 100 m lengths.

6. Flange assemblies, 12" diameter, polyethylene, incl. rings, stubs, gaskets and bolts, elbow, 50' rubber hose (12"), misc. couplings, fittings, expanders for peat slurry system.

7. Water supply pump, 12" x 12", diesel powered, low pressure.

8. 2 high pressure pumps, 2-stage, 6", diesel powered.

9. 3 hydromonitors, two 4-inch, one 3-inch, c/w nozzles of various diameter openings.

10. Misc. valves, strainer, high pressure hoses, flow meters, fittings, couplings, Y's, etc. for water supply system.

11. Gate valve, 10", flanged.

12. Electric motor, GE, 600V, 200 h.p. totally enclosed, vertically mounted.

13. Belts and pulleys (3) of various diameters for belt-drive assembly.

14. Diesel electric generator set, Cat D-398, 600 kW, 750 kVA, 3 phase, 60 cycle, 1800 rpm, trailer mounted c/w automatic shutdown protection.

TABLE 4-1 (Cont'd)

15. Reduced voltage starter, 300 h.p., 600V, c/w 100V controls, switches.

16. 150 m electric mining cable, 3 conductors, 3/0, 600V, Type GC, single piece c/w connectors.

17. 10"-16" butt fusion machine, portable, c/w auxiliary equipment.

18. 70 h.p. 4WD farm tractor c/w 3-point hitch, PTO, dual wheels front and rear.

19. Small 4WD tractor (Ford 1200) c/w backhoe attachment.

20. Bog tractor (Lannen S-10), tracked, c/w with backhoe attachment and contoured peatland bucket.

21. Miscellaneous rental equipment including:

    - D-6 bulldozer,
    - 25 ton crane,
    - boom truck,
    - 4WD service truck,
    - portable welder,
    - water pumps,
    - boat, chain saw, hand tools,
    - fuel tanks.

22. Miscellaneous supplies including:

    - fuel and lubricants,
    - lumber, timber,
    - steel cable,
    - jacks, rigging, slings,
    - small hoses, stainers, valves, etc.

TABLE 4-2

Peat and Peat Slurry Production (Averaged Data)

Test/ /Run No.	Total Time (min)	Total Peat Slurry Flow (cu.m)	Average Slurry Concentration (%)	Average Slurry Ash Content (%)	Water Add'n Coeff.	Extracted In Situ Peat (cu.m)	Practical Yield From 1 m^3 Slurry (t)	Extracted Dry Peat 0% m.c. (t)	Pump Capacity				
									Slurry (cu.m/hr)	In-Situ Peat (cu.m/hr)	Dry Peat 0% m.c. (t/hr)	Slurry USgpm (ave.)	Comments
Prelim.	60	478.44	1.04	8.93	7.65	55.31	0.00094	4.5	478.44	55.3	4.5	(2366-1979) 2107	Valve full open.
1/1	150	716.84	2.54	15.68	2.5	204.81	0.023	16.49	286.74	81.9	6.6	(1445- 722) 1263	
1/2	180	621.57	1.38	6.76	5.5	95.63	0.0124	7.71	207.2	31.9	2.6	(995-990) 912	
1/3	195	1280.9	3.02	29.87	2.0	426.97	0.0272	34.83	394.12	131.4	10.7	(2293-1309) 1735	
1/4	180	1179.84	1.61	28.05	4.6	210.69	0.0145	17.11	393.3	70.2	5.7	(1884-1560) 1732	
2/5	195	1821.30	2.47	26.93	2.5	520.37	0.0222	40.43	560.4	160.1	12.4	(3036-2199) 2468	Valve full open.
2/6	180	1346.25	2.91	26.84	2.1	434.27	0.0262	35.27	448.75	144.8	11.8	(2041-1822) 1976	
2/7	180	1113.83	2.51	24.2	2.6	312.0	0.0226	25.17	371.28	104.0	8.4	(1759-1529) 1635	
2/8	40	477.11	0.84	27.72	9.7	44.59	0.0076	3.63	716.38	67.0	5.5	(3738-2429) 3151	Valve full open.
2/8	80	570.57	0.99	25.17	8.1	62.70	0.0089	5.08	428.0	47.0	3.8	(1916-1853) 1884	
SP-1	120	923.66	2.54	30.87	2.5	263.90	0.0229	21.15	461.83	132.0	10.6	(2293-1759) 2034	
SP-2	105	842.25	2.95	34.54	2.05	276.15	0.0266	22.4	481.3	157.8	12.8	(2523-1591) 2119	Valve full open.
TOTAL	1725	11372.56				2907.39		233.78					
AVERAGE			2.28	25.35	2.92		0.0206						

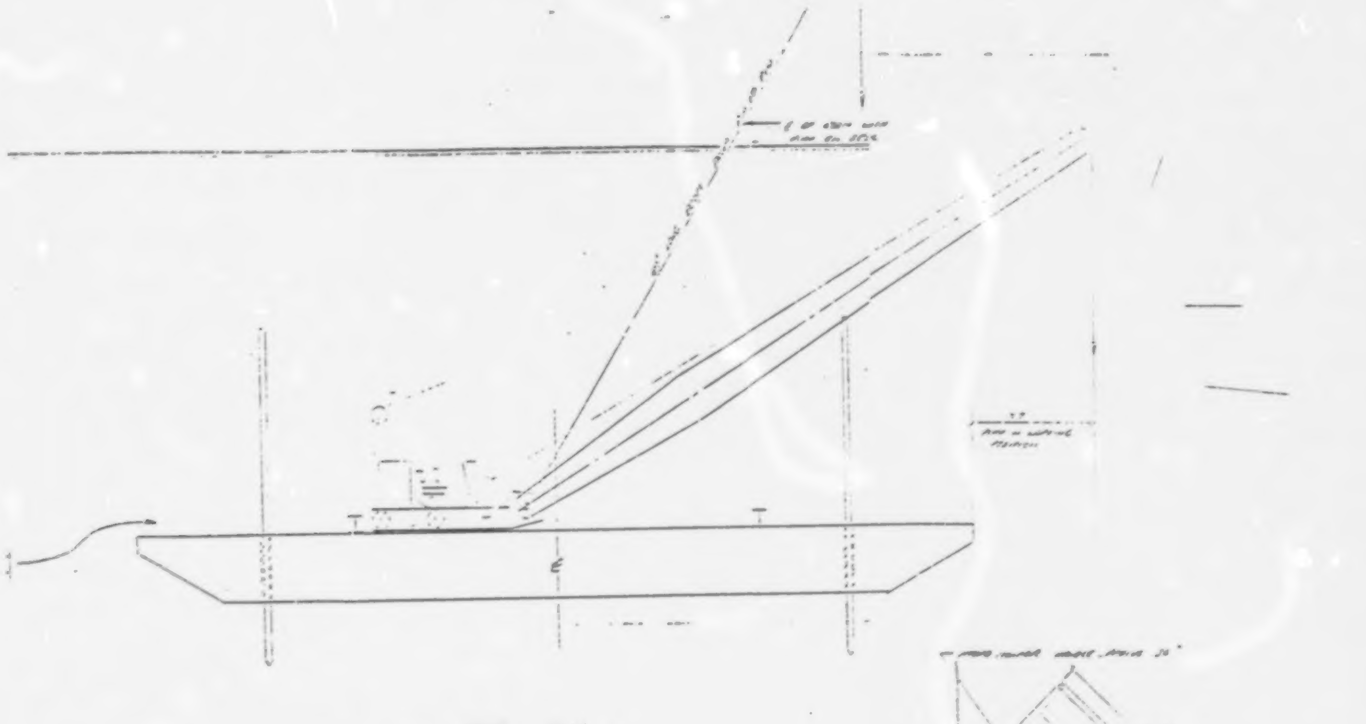


FIGURE 4-1

Scow-Mounted 'Hydropeat' Equipment

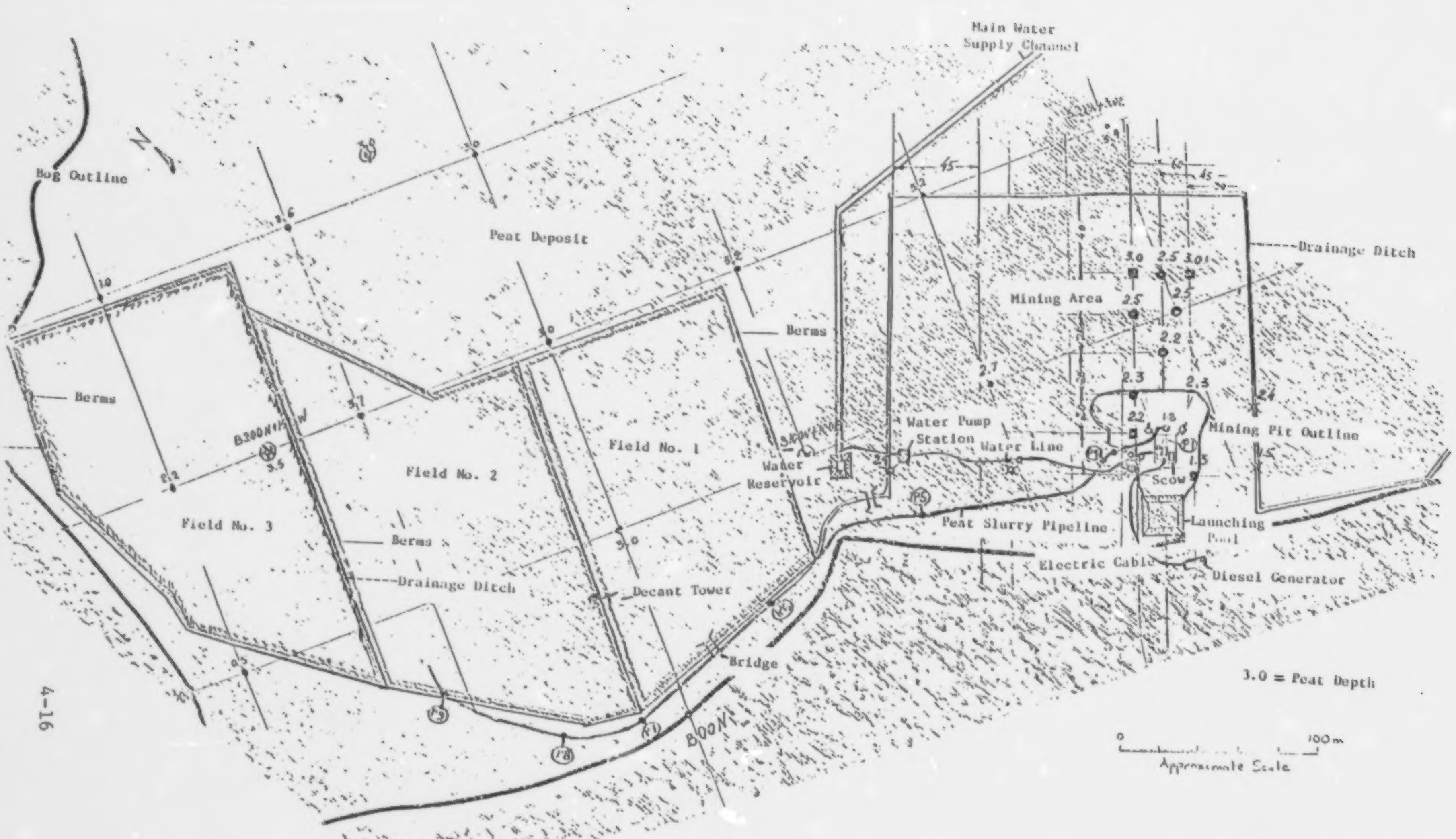

Main Water
Supply Channel
Bog Outline
N
Peat Deposit
Berms
Field No. 1
Field No. 2
Field No. 3
Berms
Berms
Drainage Ditch
Decant Tower
Bridge
BOONI
B200N
S100N
Water
Reservoir
Water Pump
Station
Water Line
Peat Slurry Pipeline
Electric Cable
Diesel Generator
Launching
Pool
Scow
Mining Pit Outline
Mining Area
Drainage Ditch
45
45
3.0
2.5
3.01
2.5
2.5
2.2
2.7
2.3
2.3
2.2
1.8
1.5
2.4
3.6
3.2
3.0
3.0
3.7
3.5
2.2
10
3.0 = Peat Depth
0
100m
Approximate Scale

FIGURE 4-2

Test Site Layout

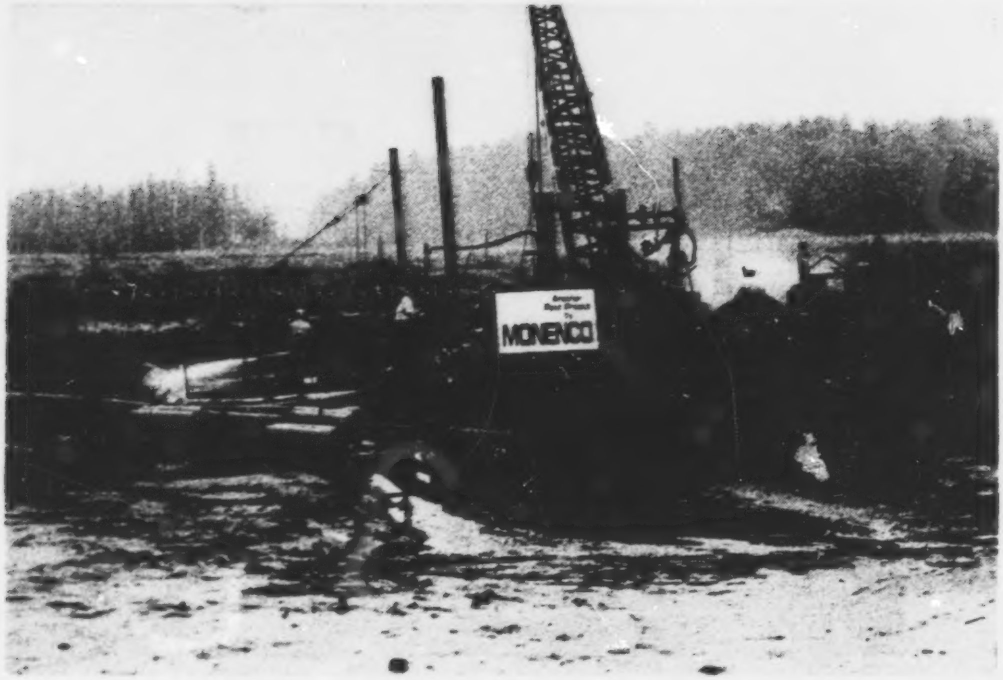


Figure 4-3. Scow Mounted "Hydropeat" Equipment (slurry pump at front, water jets break up peat).

Figure 4-4. This Method Handles Peat With High Wood Content.

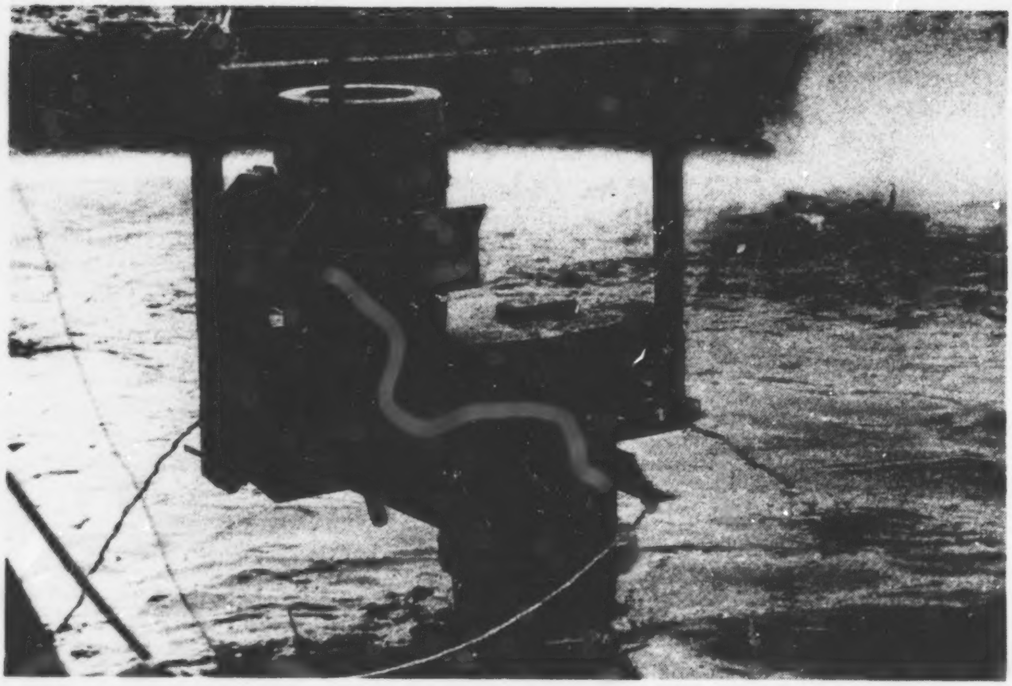


Figure 4-5. Peat Slurry Pump/Macerator (macerator section submerged).

Figure 4-6. Another View of Equipment On Scow.

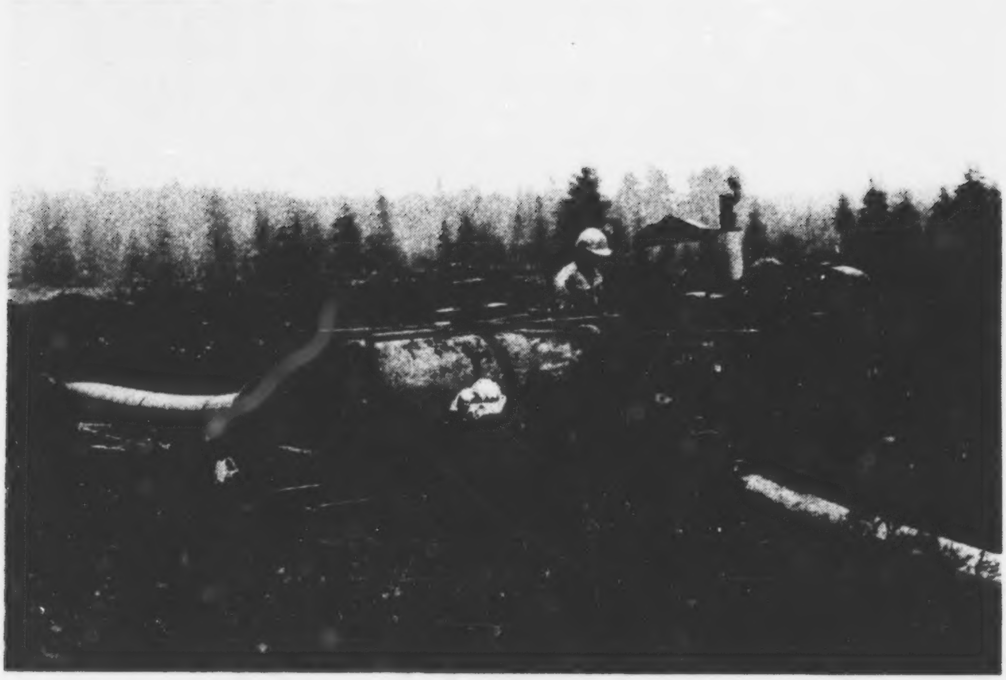


Figure 4-7. Main Water Supply Pump.

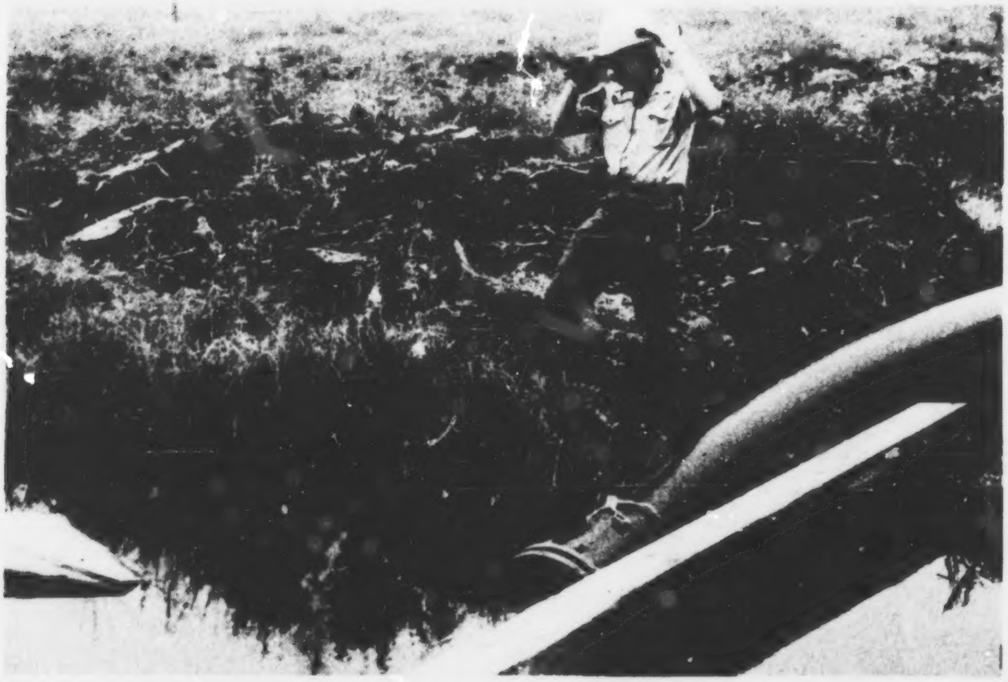


Figure 4-8. Water Supply Intake.

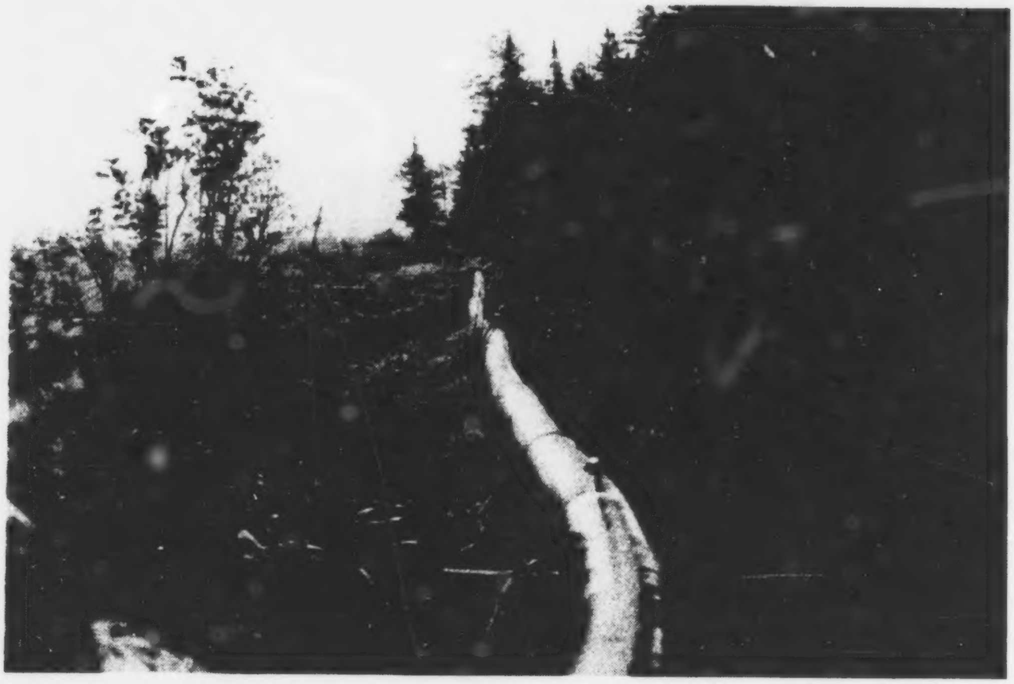


Figure 4-9. 300 mm Polyethylene Pipe Conveys Slurry to Storage Field.

Figure 4-10. Peat Slurry Discharges on Slurry Storage Field.

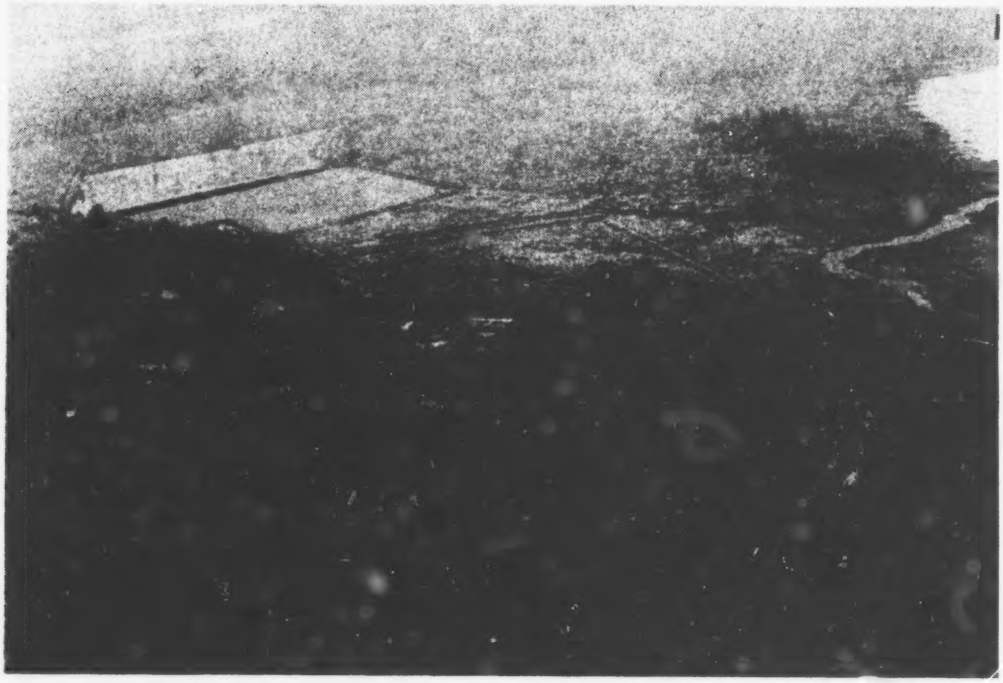
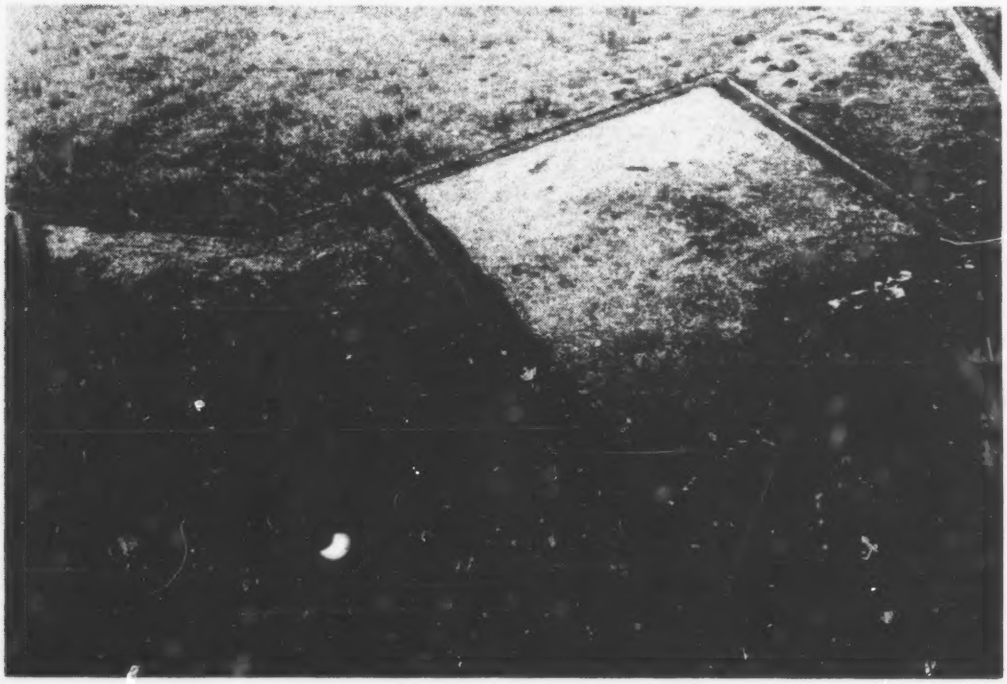


Figure 4-11. Overview of the Mine Site. The Mine Pit in the Centre; The Slurry Ponds in the Upper Left Corner.



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PART 5

PEAT SLURRY PUMPING TESTS

PART 5 - PEAT SLURRY PUMPING TESTS

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5.1 TEST PROCEDURE

In this section of the report the reader is required to differentiate between "tests" and "runs". "Tests" refer to variations in the pump characteristics (e.g. pump speed and clearance between pump impeller and wear plate) and pipeline length, and "runs" refer to changes in pumping conditions (e.g. flowrate, solids content during a "test").

Two main pumping and pipeline "tests" (Tests 1 and 2) were carried out at the site as shown in Table 5-1. A period of eight days was taken in between the tests to perform a preliminary analysis of the Test 1 data before proceeding with Test 2. As originally planned, Test 1 consisted of pumping tests at 800 rpm and 0.5 inch clearance between the impeller and wear plate. However, while at site, it was decided to carry out an additional test, "SP" (runs SP-1 and 2) at the same pump speed (800 rpm), but with a reduced clearance of 0.03 inches, since it was unknown how the pump would perform pumping peat slurry under the planned Test 2 conditions (1000 rpm and 0.03 inch clearance), designed to test its maximum capabilities. As well, previous water performance tests at the manufacturer's shop in 1985, at 800 rpm, had not included a run at 0.03 inch clearance, so information at the 800 rpm and 0.03 inch clearance was considered important for developing design calculations.

A throttling valve was installed in the pipeline and calibrated for equivalent pipeline lengths for various valve positions and the head losses were measured at the resulting changed flow rates.

511 TEST 1

A total of four "runs" were carried out during Test 1 at flowrates of 700 to 2350 USgpm through the 300 mm (12 inch) diameter, polyethylene pipeline. Each of the runs were monitored for a total period of 150 to 195 minutes, with test data being obtained every 15 minutes. The slurry pipeline length was 436 m. Figure 4-1 illustrates the peat slurry pipeline layout. The data obtained from Test 1 was analysed at the site to give a preliminary indication of the results, before continuing the test program.

512 TEST SP

After completion of Test 1, the impeller clearance was changed from 0.5 inches to 0.03 inches, and the unscheduled test (SP) at 800 rpm and 0.03 inch clearance was carried out. Two "runs" were conducted with nominal flowrates of 1600 to 2500 USgpm. Each of the runs were monitored for a period of 105 to 120 minutes. The pipeline length remained at 436 m.

513 TEST 2

For Test 2, the pump speed was increased to 1000 rpm and the clearance remained at 0.03 inches. A total of four "runs" were made with flowrates from 1500 to 3700 USgpm. Pipeline length was varied from 150 to 430 metres. Each run was monitored for a period of 120 to 195 minutes, with data recorded every 15 minutes.

During Test 2, "run" 8, the pipeline length was decreased to 264 m, and a 90° elbow was installed in the pipeline to obtain pressure drop measurements across this fitting. After 60 minutes of operation, the elbow was removed.

514 WATER TESTS

During the course of Tests 1 and 2, a total of four "runs" were carried out on water, which had been pumped into the workings to float the barge assembly to a new position. The water "runs" were made at flowrates of 2900 to 4100 USgpm. These "runs" were also not planned (i.e. not in the project statement of work), but once the test program was underway, it was decided that the information would be required as a pump performance reference point, i.e. to compare against the manufacturers shop performance test results on water. As well, data on system performance (including pipeline) on water was obtained.

5.2 INSTRUMENTATION, MONITORING AND SAMPLING

521 LAYOUT

An important aspect of the pumping trials was instrumentation of the system and the on-going monitoring program. This was carried out under separate sub-contract by Technical Services Labortories. Figures 5-1 to 5-4 inclusive are sketches of the various pipeline layouts and positioning of the instrumentation.

522 DATA RECORDED

During testing, the following data was recorded:

- pump rotational speed (rpm);
- pump discharge pressure (kPa);
- pump power demand and consumption of energy (kW, kWh);
- pump submersion (m);

- pumping operating time (min);
- slurry flowrate/velocity (USGPM, ft/s);
- slurry temperature (°C);
- pressure losses at nine locations on the pipeline (kPa); and
- pump/pipeline system elevation (m).

An elevation survey was carried out over the pipeline to establish the elevation differences between the various instrumented points, and also the locations of the various pipe bends were determined.

Table 5-2 gives information on the monitoring equipment used in the program. The Dynasonic flow meter performance was checked in the field on water and peat slurry by injecting a dye at the beginning of the pipeline and measuring the time taken to appear at the discharge end of the pipeline. Flow meter data (velocity in ft/s) was compared to observed velocities and were within ±5%. Pressure gauges, thermocouple, digital tachometer, and power demand analyser were tested and calibrated by each supplier.

523 MONITORING AND SAMPLING PROCEDURES

Three technicians were required to monitor all the equipment as well as to perform the sampling. One technician was stationed around the barge, another was stationed along the pipeline, and the third was stationed at the discharge end.

The technician on the barge monitored the following instruments: flow rate of hydromonitors #1, #2 and #3, discharge pressure of hydromonitors #1 and #2, nozzle diameter of hydromonitors #1, #2 and #3, outlet pressure of high pressure water pump #1 and #2, slurry pump discharge pressure (pressure gauge #1), rpm of electrical motor, pump submersion, and kW consumption for the electrical motor. All parameters were monitored every 15 minutes for a period of approximately three hours for each run.

The second technician monitored the slurry pipeline. Eight pressure gauges were monitored along the pipeline every 15 minutes, as well as the flowrate and temperature of the slurry. Two air evacuators were placed at the highest vertical elevations of the pipeline to release any trapped air. The throttling valve was also adjusted to the desired flowrate before each run.

The third technician was stationed at the pipe discharge and was responsible for sampling. Three samples were collected every 15 minutes. Each set of three slurry discharge samples (15 min) was combined into one sample and all the combined samples from each "run" were sent to the laboratory for moisture, ash, viscosity and s.g. determinations.

A total of 120 samples were prepared. As well, during each "run", samples were collected from the pipe discharge and sump for particle size analysis, settling and dewaterability tests. Only one set per run (2 samples, sump and discharge) were sent for analysis; a total of 20 samples were sent.

All readings were recorded on field data sheets, and then transferred to the data and calculation sheets included in Appendix A, "Peat Slurry Pump/Pipeline System Test Data".

524 LABORATORY RESULTS

The laboratory results of moisture, ash, viscosity and s.g. determinations are included in the test data sheets in Appendix A.

The results of the particle size, settling and dewaterability tests are included in Appendix F. This information is discussed later in the report. All analyses were carried out according to standard laboratory procedures.

In earlier work (Reference 1), the Thomas-Stormer viscometer was used to determine peat slurry viscosities. A comparison of results was made to viscosity measurements by the Brookfield viscometer, which indicated that the Brookfield viscometer gave similar results. For this reason, and also because the Brookfield viscometer is a much simpler instrument to operate under field laboratory conditions, the Brookfield viscometer was used in the current program for viscosity measurement.

5.3 TEST RESULTS

531 DATA COLLECTED

During the period July 24 to August 13, 1986 a total of 11 test "runs" were monitored to obtain the test data given in Appendix A. The measured data includes the slurry pump rotation speed, test duration, depth of submersion, power demand, slurry solids concentration, viscosity, ash content, specific gravity, pipeline pressures at nine locations and slurry flow velocity. As well, calculations of the main pumping and pipeline parameters were made, and are also included on the data sheets.

For ease of later reference, the three different "test" configurations are summarized below:

Test	Nominal Speed	Impeller Clearance
1	800 rpm	0.5 inches
SP	800 rpm	0.03 inches
2	1000 rpm	0.03 inches

In the case of Tests 1 and 2, data was collected for the pump with clear water as well as for the slurry. In all three cases, the data gives a range of flowrate, slurry concentration and dynamic head.

Previous shop testing by the pump manufacturer (1985) (Reference 4) resulted in pump performance data on water for the following conditions:

Nominal Speed	Impeller Clearance
1000 rpm	1 inch
1000 rpm	0.03 inch
800 rpm	1 inch

As well, information from the previous Monenco report (Reference 2) on preliminary peat slurry pumping tests carried out in New York State (1985) reviewed, and some references to the earlier study is included in this report. The pumping configurations studied at that time were:

Nominal Speed	Impeller Clearance
800 rpm	1 inch
800 rpm	0.5 inch

During the current test, it was decided to continue testing (Test 1) at 800 rpm and 0.5 inch clearance for the following reasons:

- to note the effects of changed peat characteristics;
- to note the effects of changed mining conditions (fixed position versus barge-mounted, and drained versus undrained bog);
- to note the effects of different types of pipeline material (PVC versus polyethylene pipe); and
- to perform a comparison of pump and pipeline performance data from the two tests.

532 PUMP PERFORMANCE

.1 Capacity versus Head

The previous pump performance data on water developed by the manufacturer was analysed including capacity (Q) versus head (H) curves. The manufacturer's data was used to fit a polynominal equation, often used to approximate curves, of the form:

$$H = k_1 + k_2Q + k_3Q^2 \qquad (5.1)$$

where: H - total dynamic head

Q = pump discharge

k_1, k_2, k_3 = constants selected based on pump performance data.

A polynominal for a nominal speed of 1000 rpm and 0.5 inch clearance was then interpolated between the two polynominals developed from actual test data. A linear interpolation was used based on impeller clearance. The performance curves for a nominal speed of 800 rpm and clearances of 0.03 and 0.5 inches were pro-rated from the 1000 rpm curves using the ratio of the pump head at 800 rpm/1.0 inch to 1000 rpm/1.0 inch. The estimated clear water pump characteristic curves are shown in Figure 5-5.

The resulting performance curves are considered to be estimates of the actual pump performance and are not intended to replace direct measurement of performance data for design. These curves can be used for comparison with the test data for pump performance with peat slurry.

The head developed by a pump is also expected to vary as a function of the slurry solids content, resulting in a family of pump curves for each pump configuration and slurry concentration. Reference 5 attributes changes in the pump performance characteristics to changes in the viscosity of the slurry. The expected behaviour would have a pump characteristic below the clear water characteristic but virtually unchanged at the pump shut off head. The power input to the pump should increase with concentration and the efficiency should drop. Since the rheological properties of peat slurry will vary between bogs, pump characteristics may then also vary. Therefore, design of commercial slurry pumps will require direct laboratory measurement of pump characteristics using prepared slurry of known concentration.

Figures 5-6 to 5-15 inclusive, show pump performance data for the 1986 test configurations (and manufacturers results on clear water) for selected ranges of solids content. There is a substantial amount of scatter of the data. This is thought due to fluctuations in the solids content in the peat slurry feeding the pump intake, which occurred from time to time, and caused corresponding fluctuations in pump capacity and head. Also, the monitoring and sampling for a given set of data was not recorded instantaneously at each 15 minute sampling interval. A few minutes time delay occurred between various readings due to distance between sampling points, which also may have contributed to the data scatter. No attempt was made to eliminate potentially spurious data points because of the general scatter and difficulty in identifying data which did not fit.

Examination of the data shows that the pump head developed at any given flowrate for any pump configuration tends to decrease as the slurry solids content increases. An attempt was made to define the pump performance characteristics as a function of the solids content using multiple regression analysis of the available test data. In this analysis the deviation of the measured pump head from the estimated clear water pump head was correlated with the solids content and flowrate. The amount of data available and the experimental scatter did not allow for a generalized mathematical definition of the pump performance curves as a function of the solids content. Therefore, linear regression lines were estimated from the test data as shown in Figures 5-6 to 5-15 inclusive, for use in preliminary design of commercial peat slurry pump/pipeline systems. Where the data did not show a physically realistic trend no regression analysis was conducted.

Tables 5-3 and 5-4, summarize the performance data for Tests 1, SP and 2, for different pump parameters and changes in solids concentration. Pump flowrate is shown to vary 700 to 3700 USgpm while solids concentration varied 0.7% to 4.5% (with some individual higher values) and pump head varied 6.7 m to 44.5 m. Figure 5-16 also illustrates the Q-H relationships developed for varying slurry solids conentrations for Tests 1 and 2. For the lower pump speed and greater clearance, the Q-H relationship is more sensitive to solids concentration.

Table 5-5 and Appendix C (Figures C-1 and C-2) summarize pump performance information from Tests 1 and 2, at maximum pump efficiency. It appears that over the slurry concentration range studied the pump head, efficiency and flowrate are proportional quantities, i.e. with changes in solids concentration proportional changes occur in pump head, flowrate and efficiency for a given set of pump and pipeline parameters. This was noted to be of less magnitude for the 1000 rpm and 0.03 inch clearance configuration than for 800 rpm and 0.5 inch clearance.

Pump efficiency is defined as hydraulic power divided by brake power expressed as a percent and hydraulic power is equal to discharge pressure times flowrate. As solids concentration increases, viscosity increases, and the shear forces in the fluid increase which increases the resistance of the fluid to motion. Therefore, under the same pressure gradient, the slurry of higher solids concentration travels more slowly (flowrate is less) than at low concentration. Since a higher discharge pressure head is developed by the 1000 rpm, 0.03 inch clearance than for the 800 rpm, 0.5 inch clearance pump confirguration, efficiency is higher for the former. These effects are shown in Table 5-5.

.2 Power Demand versus Flowrate

Figures 5-17 to 5-19 inclusive show the pump water power and shaft power demand (or brake horsepower expressed in kW) as a function of the flowrate. The water and shaft power demand curves were estimated from the test using the following relationships:

Water Power $WHP = QYH \cdot s.g.$ (kW)
Shaft Power $BHP = WHP \cdot n_p$ (kW)
Electric Power $EP = BHP \cdot n_m$ (kW)

where Q = pump flowrate, m^3/s
H = pump head, m
Y = specific weight of water, 9.807 kN/m^3
s.g. = specific gravity of slurry
n_p = pump mechanical efficiency
n_m = motor/electrical efficiency

The pump shaft power was computed from the measured electric power demand for an assumed motor and belt drive efficiency of 0.93 and 0.92 for the 1000 and 800 rpm configurations, respectively.

For comparison, the clear water pump shaft power demand was also estimated from the available manufacturer's test data by interpolation and proration as presented in Figure 5-20. The estimated shaft power demand curves are also shown in Figures 5-17 to 5-19, inclusive.

As discussed earlier, the pump power demand should increase as the solids content increases. Given the experimental scatter of the test data, separate mathematical relationships could not be determined; the data does tend to exhibit the anticipated increase in power demand with concentration.

As expected, the measured power demand for slurry is greater than the estimated power demand from the pump manufacturer's test data on water. Because of experimental "error", the field test for 0% solids content at 800 rpm also lies above the pump manufacturer's power demand estimates. The discrepancy between the measured power demand for clear water and the pump manufactuer's data is attributed to the following:

- the mechanical arrangement of the pump and the motor in the field which relied on pulleys and belts. This arrangement results in a lower overall efficiency because of slippage and additional mechanical components; and
- the difference between the relatively constant pump rotational speed in the manufacturer's test facility and the more variable pump rotational speed in the field.

At 1000 rpm the measured field water power agrees fairly well with the manufacturer's water power for a 0 percent solids content. This comparison suggests that the difference in the brake power demand is accounted for by the experimental arrangement rather than the fluid or the pump itself.

.3 Pump Efficiency

Figures 5-21 to 5-23, inclusive, show the measured pump efficiency data on peat slurry and the estimated manufacturer's efficiency curves on water. As expected, pump efficiency on peat slurry is less than on water. The data shown includes the complete range of solids concentration tested. Table 5-5 shows the change in best efficiency point with solids concentration, pump speed and clearance. It can be seen that efficiency decreases with increased solids concentration and is more sensitive to the 800 rpm, 0.5 inch configuration than at 1000 rpm and 0.03 inch clearance (over the range of solids contents tested). The higher maximum efficiency for the 1000 rpm/0.03 inch clearance is due to the higher pressure head at the pump discharge, which is shown to change very little over the range of solids content tested.

Further regression analyses were carried out including the effect of solids concentration. Relationships were developed for Q-H, Bhp and efficiency versus solids concentration, useful for future preliminary design calculations (see Appendix C, which also includes sample performance graphs developed from the relationships).

Although not included in the project statement of work, Monenco took the opportunity to flood the excavation workings with water on several occasions to develop pump performance data on water, to compare to the peat slurry performance results to earlier manufacturer's shop tests on water.

Table 5-6 gives average pump performance on water and peat slurry based on the actual measured data. The pump manufacturer's shop test results on water are included and when compared to the actual field pumping tests on water show that a difference exists due to the experimental design of the project, i.e., factors such as differences in motor efficiency, power supply, rotational speed, pulley and belt drive system, pulley sizes used, belt slippage, depth of submersion, etc. Also, the water at the test site was not completely clear (a slight coloration); it may have had a very slight solids content. Pump efficiency should only be compared on a relative basis within a given test since energy losses in the power transmission system were not evaluated.

The pulley and belt drive system was used to provide an economical method of studying changes in rotational speed, and once established, a direct drive arrangement would likely be preferred for industrial practice. The previous 1985 "run-in" tests and the manufacturer's shop tests on water were also carried out using the pulley-belt drive arrangement. The manufacturer's shop tests used the local utility power supply with a test voltage of about 450 V and a 150 h.p. motor; the 1985 field "run-in" tests were conducted using a diesel electric generator set (470 h.p., 437 kVA), and a 150 h.p., 460 V electric motor and a GE starter rated at 150 h.p. and 460 V; the current tests were carried out using a 600 kW, 750 kVA, diesel electric generator set, a 200 h.p. motor (600 V), and a starter rated at 300 h.p., 600 V. Different meters were used to monitor total power and power demand in all tests. It is expected the various motors had different efficiencies but these were not determined; an assumed motor efficiency was used in the efficiency calculations. The above discussion is included to emphasize that the efficiency information cannot be compared between pumping tests using different test set-ups, that it was not established on an absolute basis, and that the efficiency information should only be used to compare pump performance in relative terms between "runs" and "tests" at a given power transmission set-up.

Table 5-6 shows that the best overall pump performance was achieved on the water tests, followed by the 1000 rpm/0.03 inch clearance configuration on peat slurry, which was higher than the 800 rpm/0.03 inch clearance and 800 rpm/0.05 inch clearance peat slurry results. However, it appears that highest average solids concentrations were obtained at the 800 rpm/0.03 inch clearance pump operating conditions, which reflects total peat tonnage moved.

Comparing the manufacturer's test on water to the 1986 field test on water (at 1000 rpm/0.03 inch clearance) for the test ranges studied, the Monenco results showed a lower pump head (22% lower) but a higher flowrate (17% higher) and lower efficiency (noting the previous comment on efficiency).

5.4 HYDRAULIC ANALYSIS

541 PEAT SLURRY RHEOLOGY

The design of a peat slurry pump/pipeline system is ultimately dependent on the definition of the physical properties of the slurry, with the concentration and viscosity of the fluid slurry being the principal characteristics which must be evaluated. Information from the previous Russian experience with peat slurry systems indicates that peat slurries can be classified as non-Newtonian fluids over the range of concentrations commonly encountered.

In a Newtonian fluid, such as water, viscosity is the ratio of the shear stress to the shear rate and is independent of the shear rate. In a non-Newtonian fluid, at least one additional parameter is required to define the shear stress/shear rate relationship. A non-Newtonian fluid may be described as a pseudo plastic where motion will start with some infinitesimal rate of shear but the rate of increase in shear stress with velocity gradient decreases withincreasing velocity gradient. Several other hypothetical fluids have been proposed to explain non-Newtonian behaviour of fluids depending on the rheological characteristics of the slurry. For the design of slurry pipelines, the flow will be turbulent and the fluid shear stress will be well in excess of the Bingham fluid yield stress, therefore neither Bingham nor pseudoplastic theory can be expected to be representative of the fluid behavior as discussed in References 5 and 6.

The "effective viscosity" of a slurry is a function of the parameters used to describe the shear stress/shear rate relationship. The limiting viscosity, at large shear rate, is approximately constant for a given slurry and is therefore a function of only the concentration of solids and the suspending fluid which constitute the slurry. As the concentration of solids is increased for a given slurry, the shear stress and viscosity will both increase.

An added complication in the rheology of a peat slurry is the suggestion in Reference 5 that the slurry may be thixotropic. If this is the case, the rheogram for the fluid changes with time and with the initial maceration of the peat in preparation.

In the current test program the viscosity of the slurry sampled at the pipeline outlet was measured with a Brookfield viscometer. This instrument was operated at a constant shear rate throughout the test program, so that complete rheograms for the peat slurry at different concentrations were not developed. Each peat deposit can be expected to yield a peat slurry with different rheological characteristics as illustrated by test results in Reference 6. The present test program was designed principally as a demonstration of peat slurry pumping and pipelining methods where detailed rheological studies were not required.

Figure 5-24 shows a plot of test results of the dynamic viscosity versus the solids content by weight. A multiple regression analysis was carried out and resulted in the following relationship:

$$u = 1.073 + 3.37\,C + 2.796\,C^2 \qquad (5.2)$$

where u = dynamic viscosity of the slurry in centipoise, and

C = solids content, % by weight.

This relationship is plotted in Figure 5-24. The relationship between concentration and viscosity will be dependent on the type of solids forming the slurry so that a relationship similar to the above equation must be derived for each type of peat.

The rheological behaviour of a slurry will be dependent on the nature of the solid in the suspension including the shape and specific gravity of the particles. Each type of peat, characterized by its degree of decomposition and ash content, results in a unique relationship between the viscosity and the solids content. Figure 5-25 shows the relationship between the ash content and viscosity of the peat in the test sample. As expected, increases in the ash content tend to increase the slurry viscosity and therefore alter the transport characteristics of the slurry. The variation of ash content during the tests as the mining operation moved through the peat bog represents a source of error and scatter in relationships such as that shown in Figure 5-25.

542 PIPELINE FRICTION LOSSES

The field pipeline pressure data was used to determine the total friction and minor losses in the system. The minor losses are caused by the valve, flexible hoses, bends and expansions between the

first pressure gauge at the pump and gauge number 4 at the start of the 300 mm diameter polyethylene pipe. The friction loss is calculated between pressure gauges 4 and 5, 5 and 6, 6 and 7, 7 and 8, and 8 and 9.

The length between gauge 9 and the pipe outlet was not used in the evaluation of friction loss because of potential errors due to drawdown of the hydraulic grade line profile in the pipe near the outlet. The average head loss, in metres of slurry between each pair of gauges was then determined for assessment of the test results. The minor losses caused by the long radius pipe bends between gauge 4 and the pipeline outlet were neglected because it was felt that the magnitude of these losses would be small compared to the systematic errors associated with the measurement of the pressure data. Figures 5-26 and 5-27 illustrate the pressure losses in the pump and pipeline system based on the test data on water from Run #4 (1000 rpm/0.03 inch clearance) and on slurry from Test 2, Run #5 (1000 rpm/0.03 inch clearance), respectively.

Examination of the test data (Appendix D "Friction Loss, Critical Length Calculations) shows a significant variation in the loss per metre between adjacent pairs of gauges. The variation can be attributed to several sources as will be discussed in a later section. The data does show that there is not a consistent "steady state" friction loss in the pump/pipeline system. Therefore, the average head loss per metre can be expected to scatter around the actual or measured head loss depending on the potential errors in each of the separate gauge readings.

Friction losses in any pipeline are generally accepted to be a function of the velocity, V; the pipeline diameter, D; the roughness of the pipe wall, k; and a parameter describing the fluid, usually the kinematic viscosity. The determination of the friction loss for Newtonian fluids, such as water not transporting solids, is well defined and can be determined from the D'Arcy Weisbach expression:

$$h_F = f \frac{LV^2}{D2g} \qquad (5.3)$$

where: f = friction factor

The friction factor is estimated by the Moody diagram as a function of the Reynolds number and the relative roughness of the pipe wall.

In the case of a non-Newtonian flow such as a peat slurry, attempts (References 7, 8 and 9) have been made to identify parameters which can be used to represent flow behaviour on a generalized diagram similar to the Moody diagram. Several approaches are identified in Reference 8 for the determination of the slurry friction factor for both laminar and turbulent flows. However these methods are based on the laboratory determination of the fluid rheograms not available from the current test data.

In earlier Monenco studies (References 1 and 6) some preliminary rheological investigations were carried out at the University of Toronto laboratories including determinations of shear rate versus shear stress for various peat slurry concentrations, for peat samples from Ontario and Saskatchewan. They showed that the slurry was non-Newtonian and there was definite evidence of a yield stress, and at the higher concentration a non-linear relationship was exhibited between shear stress and shear rate. At a given concentration, the apparent viscosity of the slurry decreased with increasing shear rate, thought to be a reflection of further separation and alignment of fibers under shear.

In another Monenco study (Reference 3), early work in the Soviet Union (1941) was shown, which utilized the D'Arcy Weisbach relationship giving a friction factor estimated by the expression:

$$f = \frac{0.975u}{8.1V(6.16)D^2} \qquad (5.4)$$

Analysis of the expression shows that the friction factor is not accurately estimated (see Figures 5-28 and 5-29) compared to actual test data from the current program. This formula does not appear to be of value for estimating slurry pipeline head losses, although it should be noted that the Russian experience was based on using steel pipe of large diameter, with flanged and bolted connections.

Based on further detailed review of the Russian hydropeat experience and data, an empirical relationship (1954) was found (Reference 10) which was used for engineering design calculations to estimate pipeline slurry friction losses based on experience with commercial systems. It is presented as follows:

$$H_f = \left[0.9 \frac{u^{0.6}}{D^{1.3}} + 0.8 \frac{V^2}{u^{0.2} D^{1.3}}\right] \frac{1}{1000} \qquad (5.5)$$

where: H_f = head loss per meter
u = dynamic viscosity, poise
D = pipeline diameter, meters, and
V = mean pipeline velocity, m/s

This expression is considered to be correct for a peat slurry over a specific range of concentrations, and was based on a viscosity determined at a constant viscometer shear rate. In practice, the relationship was used for design of systems with a narrow range of pipeline velocity. Since the formula does not take the variation of viscosity with velocity into account, it has limitations in its application to slurries over a greater range of shear rate than was used for development of the expression.

Any generalized treatment of pressure losses in slurry pipelines must include assumptions about the rheological behaviour of the fluid. In the case of peat, there is not a sufficient body of data available to select a common rheological model of all peat deposits. In addition, the thixotropic behaviour of some peats will make the selected model dependent on length of the pipeline and the maceration by the pump. Therefore, pilot plant tests will be required for design of commercial scale systems. Pilot test data can be scaled from the test pipeline diameter to other pipeline diameters using procedures recently presented in Reference 11. Similitude between two pipes of different diameter can be achieved by ensuring that the wall shear stress in the two pipes is the same. When this condition is satisfied, the head loss versus velocity relationship from the test data can be scaled as follows:

$$V_2 = V_1 + 2.5\, u_* \ln(D_2/D_1) \qquad (5.6)$$

$$(\Delta p/\Delta x)_2 = (\Delta p/\Delta x)_1 (D_1/D_2) \qquad (5.7)$$

where V_2 = mean velocity required,

V_1 = mean velocity test data,

D_1 = diameter of test pipeline,

D_2 = diameter of required pipelines,

$(\Delta p/\Delta x)_1$ = pressure loss in test pipelines,

$(\Delta p/\Delta x)_2$ = pressure loss in required pipelines, and

u_* = shear velocity

$= \sqrt{w/p}$

The equations enable non-Newtonian, turbulent data points to be scaled to pipelines of different diameters.

The data collected during the field pumping trials provides prototype scale information for the selection of an appropriate procedure for design of peat slurry pipeline systems. Additional data from Reference 7 was also incorporated into the analysis of pipeline pressure losses.

In Figure 5-30 the average head loss per metre data is plotted as a function of the velocity in the pipeline. With the exception of a few points lying above the general trend of the data, a clear relationship can be seen. This data may be scaled as described above to determine head loss, for the specific peat, for other pipeline diameters.

The head loss is plotted as a function of the solids content in Figure 5-31. No clear relationship can be deduced from this data. The expected behaviour would result in greater head losses as the solids content (and viscosity) increases. With the limited range of solids content experienced in the test program, there is not a detectable change in head loss.

The empirical relationship suggested in the 1954 Russian peat slurry design methodology was also tested against the data. In Figure 5-32 the average head loss per metre is plotted as a function of the first term in the equation. This term reflects the influence of viscosity on the head loss. The data is scattered and does not imply any relationship.

The second term of the equation is plotted against the average head loss data in Figure 5-33. There is substantially less scatter in this data reflecting the influence of the velocity on this term.

In Figure 5-34 the average head loss computed from the data shows that the relationship tends to overestimate the head loss slightly but there is relatively little scatter. This formula is empirical having been developed over several years of peat slurry pumping experience for a narrow range of velocities encountered in pipeline design and does not properly reflect the variation of the viscosity and velocity.

This relationship was originally developed for pipeline diameters in the range of 600 to 700 mm, for steel pipe. The current tests were carried out using a butt-fused, polyethylene pipeline of 190 mm inside diameter, which may account for the lower measured head losses.

543 CRITICAL LENGTH CONCEPT

Russian experience with the design of peat slurry pump/pipeline systems summarized in References 1 and 2 includes the concept of a "critical length". This concept states that beyond the critical length, the flowrate does not change as the length of the pipeline is increased. This concept was tested by computing the total equivalent length of the pipeline. The equivalent length is the pipeline length required to give the same head loss if all minor losses were to occur as friction losses.

For a hypothetical system consisting of a pump and a straight horizontal pipeline with no minor losses, the flowrate can be found from the interaction of the pump characteristic and the pipeline system curves. If a polynominal of the form shown in Equation 5.1.

is used, the flowrate can be found as a function of length from the following expression:

$$Q = \frac{-k_2 - (k_2{}^2 - 4\ (k_3 - k_4L)\ k_1)^{\frac{1}{2}}}{2\ (k_3 - k_4L)}$$

where k_1, k_2 and k_3 are constants selected by multiple regression analysis of pump performance data.

$k_4 = f/A^2D2g)$,
L = pipeline length,
Q = flowrate,
A = pipe area,
D = pipe diameter,
f = friction factor.

Figure 5-35 shows a plot of pipeline flowrate versus pipeline length from this equation. In this graph, the constants k_1, k_2 and k_3 from the 1000 rpm, 0.03 inch clearance pump were used and k_4 was evaluated for a 300 mm diameter pipeline. This analysis shows that even for clear water, the rate of change of flowrate with increasing length is reduced as the length of the pipeline increases.

In a peat slurry pump/pipeline system both the pump characteristic and the pipeline system curves are expected to change as a function of the properties of the slurry. As the length of the pipeline increases, the intersection point between the pump characteristic curve and the pipeline system curve changes. However, in the case of peat slurry, the change in flowrate as the pipeline length changes can be compensated for by the variation in head loss and pump head with viscosity. The net effect is that the change in flowrate with pipeline length apparently becomes insignificant, for design purposes, at a pipeline length, greater than approximately 1000 metres.

In Figures 5-36, 5-37 and 5-38, the flowrate data is grouped by solids content and is plotted as a function of the equivalent length of pipeline for the different pump configurations tested. The data does indicate that the rate of change of flowrate with increasing pipeline length is reduced when the length of the pipeline exceeds approximately 1000 metres. It is apparent from these plots that the change of flowrate with length also decreases as the solids content increases.

In Figures 5-39, 5-40 and 5-41, the variation of the pump head with length at various concentrations is shown for comparison purposes. When the pipeline length is increased, the pump head will become assymtotic to the pump shut off head as the flowrate becomes assymtotic to zero. It is not possible to provide a definitive illustration of the effect of solids content given the amount of scatter in the test data and, because of the complicating effect of the concentration/viscosity, it is not possible to postulate a mathematical expression for this behaviour in a peat slurry, at this time. Regression analysis was used to provide estimates of the variation of the pump head and flowrate with equivalent length as shown in the abovementioned Figures. Note that the resulting curves are only for illustration purposes and do not provide physically meaningful extrapolation of the data.

5.5 PEAT SLURRY PUMP/PIPELINE SYSTEM DESIGN

For the design of peat slurry pump/pipeline systems the following conclusions have been reached:

- The relationship between velocity and viscosity does not appear to be important for the high rates of shear and turbulent conditions encountered in a prototype system.

- Concentration and viscosity can be predicted for each type of peat from equations similar to Equation 5.2.

- The test data can be used to give an estimate of the pump characteristic curves for preliminary design purposes. Direct laboratory measurement of pump characteristic curves using prepared slurry of known concentrations and properties will be required for detailed design of commercial peat slurry pump/pipeline systems.

- The pump power demand will be greater when pumping slurry than when pumping clear water. Direct measurement of this parameter will also be required for detailed design of commercial peat slurry pump/pipeline systems.

- Friction losses in the pipeline can be determined by the empirical Russian formula, Equation 5.5. The test program confirms the applicability of this formula for pipeline diameters of 300 mm. The formula is generally applicable to peat slurry head loss in pipelines and is independent of the characteristics of the pump.

- A critical length appears to exist beyond which further increases in length have little effect on the flowrate. An explanation for this behaviour has been proposed based only on the hydraulic performance of the pump and the pipeline. Confirmation of the phenomena will require an additional test program which would separate the variations caused by hydraulic systems from those caused by the mining operation.

Because of the difficulty in developing generalized theoretical design procedures, the design of peat slurry pump/pipeline systems should be based on test data for the specific peat types and systems being considered.

Appendix E includes an example approach for design of a peat-slurry/pipeline system.

5.6 SOURCE OF ERRORS

The nature of the test program, combining mining and hydraulic aspects, results in several significant sources of experimental errors. These errors then manifest themselves in the scatter of the test data presented in the preceding sections.

In the mining of the peat, extra water was often added associated with the high stump content. This resulted in variations in the slurry concentration and viscosity continuously along the pipeline. At other times, the pump became clogged with roots, stumps, grass and other material not deflected by the stump deflector or macerated insufficiently to flow through the pump. This caused changes in the flowrate through the course of the test. In addition, the hydromonitors were often directed at the pump to flush away the debris. This process was successful from a mining standpoint but entrained air in the flow entering the pipeline and also affected the discharge. The air changes the bulk specific gravity of the slurry and, when it leaves suspension, forms larger bubbles along the pipeline. These bubbles effectively block a portion of the flow area increasing losses in the system and resulting in pressure fluctuations, until removed.

The flow variations at the pump also produce pressure transients along the pipeline.

The monitoring of the pressure data required that a technician travel along the length of the pipeline recording pressure data at the gauge locations. For the unsteady, non-uniform, fluid flow conditions encountered, this procedure did not give continuous or instantaneous recording of the data. Thus, the slurry characteristics along the pipeline may be substantially different from the conditions at the sampling station at the pipe outlet. The pressure varied in the pipeline with changes in pump flowrate and fluid properties so that the pressure differential recorded by the technician at adjacent gauges may not reflect the actual continuously changing pressure differential.

In addition to errors caused by the mining system, the more usual systematic errors such as gauge sensitivity, meter sensitivity, etc. were also present. The magnitude of these errors is assumed to be small compared to the potential errors caused by the mining process.

The data can be considered to be reasonably representative of slurry pump/pipeline systems when the magnitude of potential error sources are accounted for. There can be no rigourous method for removal or specification of the exact error caused by the mining operation.

5.7 SUMMARY

The test program was designed to evaluate the feasibility of commercial scale hydraulic mining and hydraulic transportation of peat. The results of the test program may be summarized as follows:

1) Hydraulic mining and slurry transport of peat is a proctical method of harvesting peat. The successful operation of the demonstration scale system provides confirmation of the viability of larger commercial scale systems.

2) Concentration and viscosity can be predicted for each type of peat from equations similar to Equation 5.2.

3) The pump characteristics curves developed from the test data illustrate the effect of the slurry solids content on the head produced by the pump. The data may be used for preliminary design of a peat pumping system and indicate the importance of including solids contents as one of the parameters used in pump manufacturers' performance testing.

4) The pump power demand will be greater and the efficiency will be lower when pumping slurry than when pumping clear water. Direct measurement of this parameter will also be required for detailed design of commercial peat slurry pump/pipeline systems.

5) The pump/pipeline system is hydraulically stable and yields a consistent relationship between the slurry velocity and the head loss in the pipeline.

6) A relationship between the head loss in the pipeline and the solids content of the slurry apparently does exist. However, this relationship is not as important as the relationship between head loss and velocity.

7) The head loss from the test program can be scaled to give head losses for different pipeline diameters for design of commercial systems for similar peat deposits. The scaling procedure can be carried out for the solids content used in the test program. If other solids contents are required for design, interpolations may be carried out. For design of commercial systems with different peats, pilot tests will be required to provide scale data.

8) The Russian formula used in the 1954 Design Handbook includes viscosity measured at a constant shear rate. In this formula, the variation of the viscosity with velocity is not taken into account therefore it has limitations in its application to slurries with a wide range of viscosity. However, because the formula relies mainly on the velocity to predict the head loss, it does give a reasonable estimate of the head loss. However, a better correlation can be found by scaling the test data.

9) The "critical length", beyond which further increases in pipeline length have little effect on the system flowrate appears to occur because of the relationship between the pump characteristic and pipeline system curves. This effect can be illustrated for clear water pipelines and apparently becomes more noticeable as the solids content affects the pump head and friction losses. Further study would be required to separate the variations caused by the hydraulic systems from those caused by the mining operation.

10) The current test program was designed to test the feasibility of potential commercial scale hydraulic peat mining systems. If further research is carried out it should include detailed rheological studies and laboratory determinations of head losses to develop a generalized analytical model to reduce or eliminate the need for pilot testing of future commercial slurry systems.

Because of the difficulty in developing generalized theoretical design procedures, the design of peat slurry pump/pipeline systems should be based on test data for the specific peat types and systems being considered. Further monitoring of prototype installations is recommended for the development of design procedures, theoretical background and optimization of the systems.

TABLE 5-1

Test Variations

Nominal Pump Speed (rpm) and Impeller Clearance (inches)	Peat Slurry				Water			Actual Pipeline Length (m)	Equivalent Pipeline Length (m)
	Test	Run	Range of Flowrate (USgpm)	Number of Samples	Test	Run	Flowrate (USgpm)		
800 rpm, 0.5" CLR	1	Prelim	2000 to 2350	4				436.5	
		1	700 to 1400	10				436.5	
		2	200 to 1000	12				436.5	
		3	1300 to 2300	13				436.5	635
		4	1550 to 1900	12				436.5	
800 rpm, 0.03" CLR	1 SP	SP-1	1750 to 2300	8	SP	1	2900 to 3000	436.5	598
		SP-2	1600 to 2500	7					591
1000 rpm, 0.03" CLR	2	5	2200 to 3000	13	2	2	3700	429.6	535
		6	1800 to 2000	12				429.6	
		7	1500 to 1750	12				429.6	
		8a	2400 to 3700	4		3a	3570	264.0	
		8b	1850 to 1900	8		3b	3570	250.2	
						4	3300 to 4100	250.2	
TOTAL	3	11		115					

TABLE 5-2

Instrumentation Used

Quantity	Item	Error
9	(Ashcroft) Pressure Gauges (0-400 KPa) with 1 KPa resolution, 4½" dial	+/- 1%
9	(Ashcroft) Stainless Steel seals for above pressure gauges.	
9	Oil fill for above gauges	
1	(Branetz 808) Electrical power/demand analyser with print out	+/- 0.1%
1	(Shimpo DT-5AP) Tachometer, 12v D.C. with digital r/o	+/- 0.1%
1	Magnetic pick-up with 50 ft cable (for tachometer)	
1	(Dynasonic (UFT-603)) Ultrasonic flow meter	+/- 5% repeatability +/- 1%
4	(Motorola 5 watts) "Walkie-Talkies"	
1	(Fluke) Thermocouple Temperature gauge	+/- 0.2%
1	End of pipe sampling device	
1	(Honda) 3500 Watt generator	
1	575 to 115 step down transformer	
1	12 volt battery	

TABLE 5-3

Summarized Pump/Pipeline Performance Data for Different Solids Concentrations (800 rpm, 0.5 and 0.03 inch pump clearances and 436.5 m pipeline length)

Parameter	Unit	Clearance Between Impeller and Wear Plate (Inches)					
		0.5	0.03	0.5	0.03	0.5	0.03
		Slurry Solids Concentration (%, weight basis)					
		0.8–1.95	1.0–1.85	2.0–2.9	2.2–2.95	3.1–6.3	3.0–4.1
A. PUMP			*		*		*
Speed	rpm	770– 796	791	740– 794	789– 792	755– 793	777– 792
Efficiency	%	12– 22	18– 23	13– 18	18 – 30	8– 19	15– 28
Flowrate	USgpm	900–2200	1900–2300	700–2100	2000–2500	1300–2300	1600–2400
Discharge Head	m	9.5–21.4	11.7–12.7	8.4–17.6	10.6–14.9	6.7–12.8	10.8–14.1
Brake Horsepower	hp	92– 102	100– 104	71– 104	97– 106	91– 121	93– 105
B. PIPELINE							
Velocity	m/s	0.9– 2.1	0.9– 2.1	0.7– 2.1	1.9– 2.4	1.3– 2.2	1.5– 2.3
Viscosity	cp	5– 22	8– 23	7– 80	12– 23	26– 170	42– 68
Temperature	°C	17– 22	17– 19	17– 21	17– 19	16– 21	16– 19
Head Loss	m/100m	0.3– 1.6	1.6– 2.2	0.5– 1.4	0.5– 1.4	0.8– 1.6	1.4– 2.3
Static Head	m	1.8– 2.4	1.5– 1.8	1.8– 2.5	1.8– 2.5	1.9– 2.2	1.6– 1.9

TABLE 5-4

Summarized Pump/Pipeline Performance Data for Different Solids Concentrations (1000 rpm, 0.03 inch Clearance and 250 to 430 m Pipeline Length)

Parameter	Unit	Range of Test Data Slurry Solids Concentration (% by weight) 0.7 - 1.9	 2.0 - 3.0	 3.1 - 4.5
A. PUMP				
Speed	rpm	965 - 1045	1031 - 1055	994 - 1044
Efficiency	%	12.3 - 33.7	11.5 - 30.2	12.6 - 29.3
Flowrate	USgpm	1600 - 3700	1500 - 2900	1600 - 2500
Discharge Head	m	13.9 - 44.5	13.0 - 44.4	14.1 - 44.4
Brake Horsepower	hp	169 - 244	205 - 238	202 - 231
B. PIPELINE				
Velocity	m/s	1.5 - 2.9	1.5 - 2.7	1.5 - 2.5
Viscosity	cp	5 - 26	16 - 55	36 - 68
Temperature	°C	16 - 20	16 - 19	17 - 19
Head Loss	m/100 m	1.2 - 4.3	1.0 - 3.8	1.2 - 3.0
Static Head	m	1.7 - 2.4	1.8 - 2.0	1.9 - 2.0

TABLE 5-5

Peat Slurry Pump Performance Results at Maximum Pump Efficiency

Parameter	Unit	Average Solids Concentration (% by weight)					
		1.5%		2.5%		3.5%	
		800 rpm 0.5 inch Clearance	1000 rpm 0.03 inch Clearance	800 rpm 0.5 inch Clearance	1000 rpm 0.03 inch Clearance	800 rpm 0.5 inch Clearance	1000 rpm 0.03 inch Clearance
Best Efficiency Point	%	17.6	25.8	16.4	25.5	15.3	25.3
Flowrate	USgpm	1451	1611	1404	1606	1357	1601
Discharge Head	m	14.3	42.7	13.8	42.6	13.3	42.5
Brake Horsepower	hp	98	221	97.8	222.2	97.6	223.4

TABLE 5-6

Average Performance On Water and Peat Slurry at Different Pump Speeds

(Range)
(Average)

Parameter	Unit	800 rpm/ 0.5 inch Clearance	800 rpm/0.03 inch Clearance		1000 rpm/0.03 inch Clearance		
		1986 Field Data on Slurry	1986 Field Data		Manufacturers Test Data on Water	1986 Field Data	
			Water	Slurry		Water	Slurry
Rotational Speed	rpm	740 - 796 787	792	777 - 792 790	1000	1031 - 1047 1042	965 - 1055 1037
Efficiency	%	8 - 22 15.2	40 - 42.4 41.3	15 - 30 21	14.8 - 60.5 46.0	26.5 - 48.3 38.2	11.5 - 33.7 23.4
Flowrate	USgpm	700 - 2300 1420	2900 - 3000 2980	1600 - 2500 2070	530 - 5480 2980	2000 - 4100 3500	1500 - 3700 2104
Head	m	6.7 - 21.4 13.9	18.3 - 19.0 18.6	10.2 - 14.9 12.3	20.8 - 51.5 39.3	21.4 - 44.0 30.8	13.0 - 44.5 32.9
Brake Horsepower	hp	71 - 121 97	111 - 112 111.3	93 - 106 101	152 - 204 181	217 - 246 228.7	169 - 244 224
Slurry Solids Concentration	% by weight	0.8 - 6.3 2.1	0	1 - 4.1 2.7	0	0	0.7 - 4.5 2.2

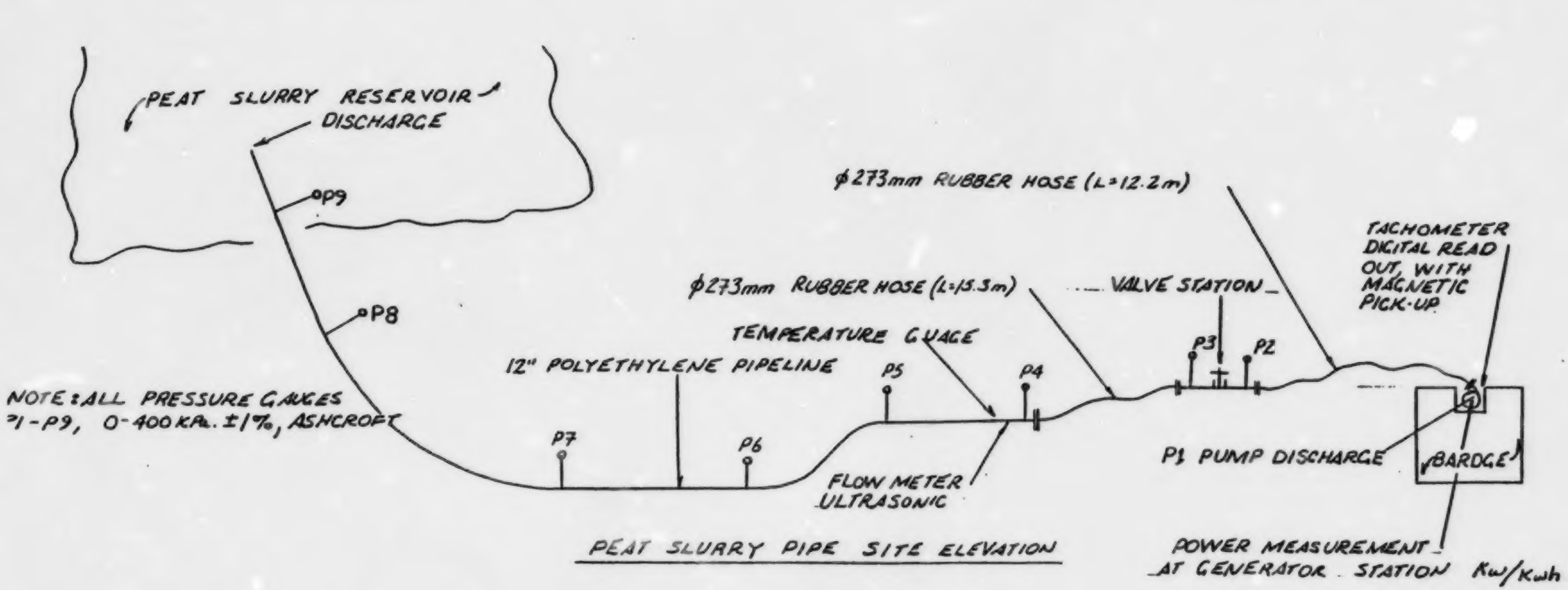

PEAT SLURRY RESERVOIR
DISCHARGE
P9
P8
NOTE: ALL PRESSURE GAUGES P1-P9, 0-400 KPa. ±1%, ASHCROFT
P7
12" POLYETHYLENE PIPELINE
P6
P5
TEMPERATURE GUAGE
ϕ273mm RUBBER HOSE (L=15.3m)
ϕ273mm RUBBER HOSE (L=12.2m)
FLOW METER ULTRASONIC
P4
VALVE STATION
P3
P2
TACHOMETER DIGITAL READ OUT, WITH MAGNETIC PICK-UP
P1 PUMP DISCHARGE
BARDGE
POWER MEASUREMENT AT GENERATOR STATION Kw/Kwh
PEAT SLURRY PIPE SITE ELEVATION

FIG. #1

For Preliminary Test, Slurry Test #1 (Runs No. 1,2,3 & 4), Slurry Test Special-1 & Special-2 and for Water Test #1

Pipeline length total	= 436.5
Expander ϕ8"/10" & flanch, length	= 0.8 m
Rubber hose, ins. ϕ273 mm, length	= 12.2 m
Valve skid, ins. ϕ230 mm, length	= 5.8 m
Rubber hose, ins. ϕ273 mm, length	= 15.3 m
Expander ϕ 10"/12" & flanch, length	= 0.8
12" polyethylene pipeline, length	= 401.6 m
TOTAL	= 436.5 m

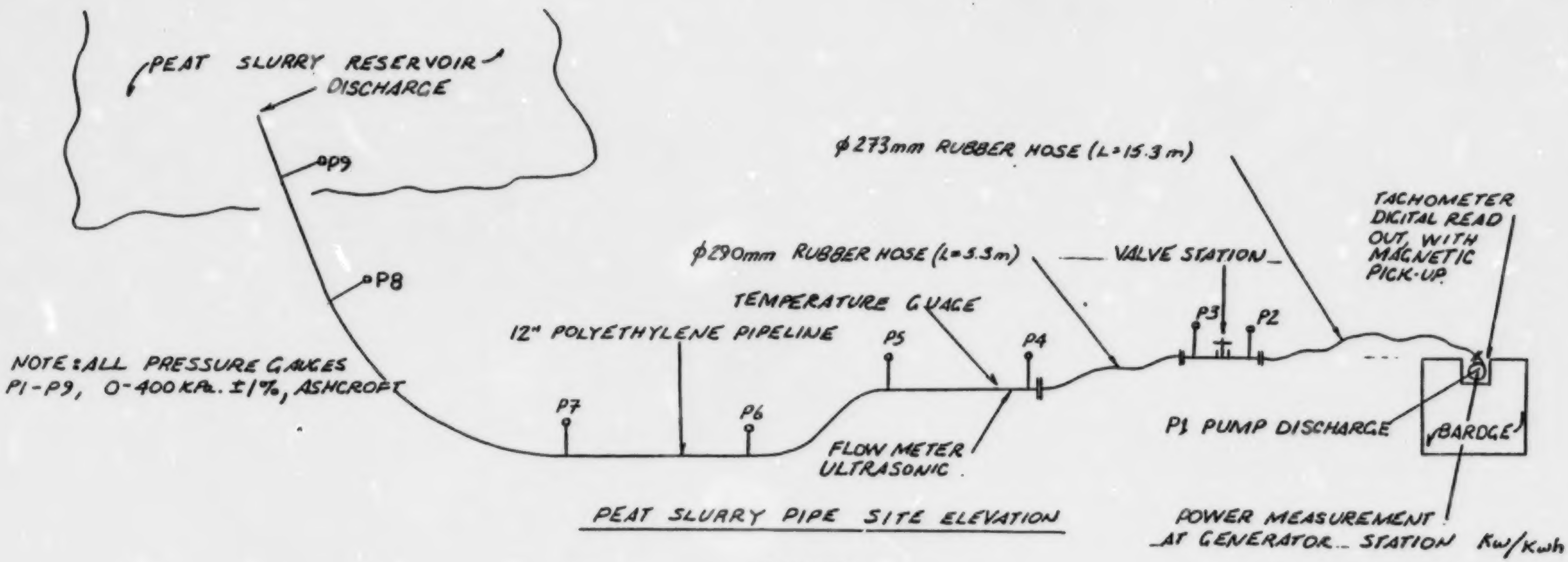
Pipeline Distances Between Gauges:

P1 - P2 = 14.9 m
P2 - P3 = 3.15 m
P3 - P4 = 12.5 m
P4 - P5 = 100 m
P5 - P6 = 92 m
P6 - P7 = 25.6 m
P7 - P8 = 41.4 m
P8 - P9 = 64.4 m
P9 to end of pipeline=15.8 m

*Note: Gauge P1 was 45 cm higher than surface of barge

FIGURE 5-1

Slurry Pipeline Layout for Tests 1 and SP


PEAT SLURRY RESERVOIR
DISCHARGE
P9
P8
NOTE: ALL PRESSURE GAUGES
P1-P9, 0-400 KPa. ±1%, ASHCROFT
P7
12" POLYETHYLENE PIPELINE
P6
P5
TEMPERATURE GUAGE
FLOW METER
ULTRASONIC
P4
ϕ290mm RUBBER HOSE (L=5.3m)
VALVE STATION
P3
P2
ϕ273mm RUBBER HOSE (L=15.3 m)
TACHOMETER
DIGITAL READ
OUT, WITH
MAGNETIC
PICK-UP
P1 PUMP DISCHARGE
BARGE
POWER MEASUREMENT
AT GENERATOR STATION Kw/Kwh

PEAT SLURRY PIPE SITE ELEVATION

FIG. #2

For Slurry Test #2 Runs #5,6 & 7
and Water Test #2
Pipeline length total = 429.6 m

Expander ϕ8"/10" & flanch, length	= 0.8 m
Rubber hose, ins. ϕ = 273 mm, length	= 15.3 m
Valve skid, in. ϕ = 230 mm, length	= 5.8 m
Expander ϕ 10"/12" & flanch, length	= 0.8 m
Rubber hose, ins. ϕ = 290 mm, length	= 5.3
12" polyethylene pipeline, length	= 401.6 m
TOTAL	= 429.6 m

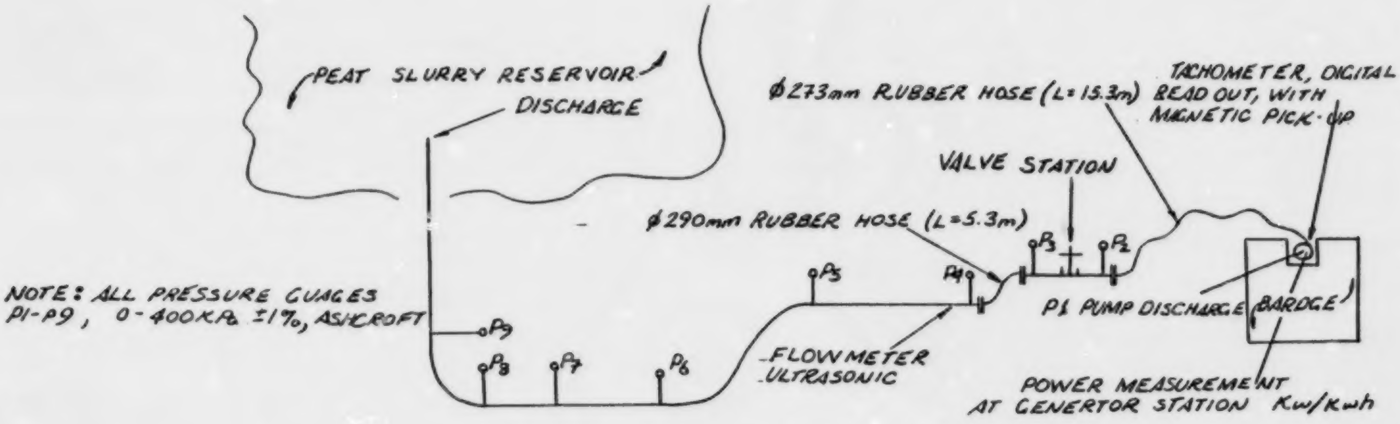
Pipeline Distances Between Gauges:

P1 - P2 = 18 m
P2 - P3 = 3.15 m
P3 - P4 = 8.5 m
P4 - P5 = 100 m
P5 - P6 = 92 m
P6 - P7 = 86.6 m
P7 - P8 = 41.4 m
P8 - P9 = 64.4 m
P9 to end of pipeline=15.8 m

*Note: Gauge P1 was 45 cm higher than surface of barge

FIGURE 5-2

Slurry Pipeline Layout for
Test 2, Runs 5,6, and 7


PEAT SLURRY RESERVOIR
DISCHARGE
NOTE: ALL PRESSURE GUAGES P1-P9, 0-400KPa ±1%, ASHCROFT
P9
P8
P7
P6
P5
FLOWMETER ULTRASONIC
ϕ290mm RUBBER HOSE (L=5.3m)
P4
P3
VALVE STATION
P2
ϕ273mm RUBBER HOSE (L=15.3m)
TACHOMETER, DIGITAL READ OUT, WITH MAGNETIC PICK-UP
P1 PUMP DISCHARGE
BARDGE
POWER MEASUREMENT AT GENERTOR STATION Kw/Kwh

PEAT SLURRY PIPELINE SITE ELEVATION

FIG. #3

For Slurry Test #2, Run #8
(First four measurements) and
Water Test #3 (first two measurements)
Pipeline length total = 264 m

Expander ϕ8"/10" & flanch, length = 0.8 m
Rubber hose, ins. ϕ273 mm, length = 15.3 m
Valve skid, ins. ϕ230 mm, length = 5.8 m
Expander ϕ 10"/12" & flanch, length = 0.8 m
Rubber hose, ins. ϕ290 mm, length = 5.3 m
12" polyethylene pipeline, length = 236 m

TOTAL = 264 m

Pipeline Distances Between Gauges:

P1 - P2 = 18 m
P2 - P3 = 3.15 m
P3 - P4 = 8.5 m
P4 - P5 = 100 m
P5 - P6 = 49.4 m
P6 - P7 = 42.6 m
P7 - P8 = 27.8 m
P8 - P9 = 4.3 mm
P9 to end of pipeline=10.5 m

FIGURE 5-3

Slurry Pipeline Layout for
Test 2, Run 8

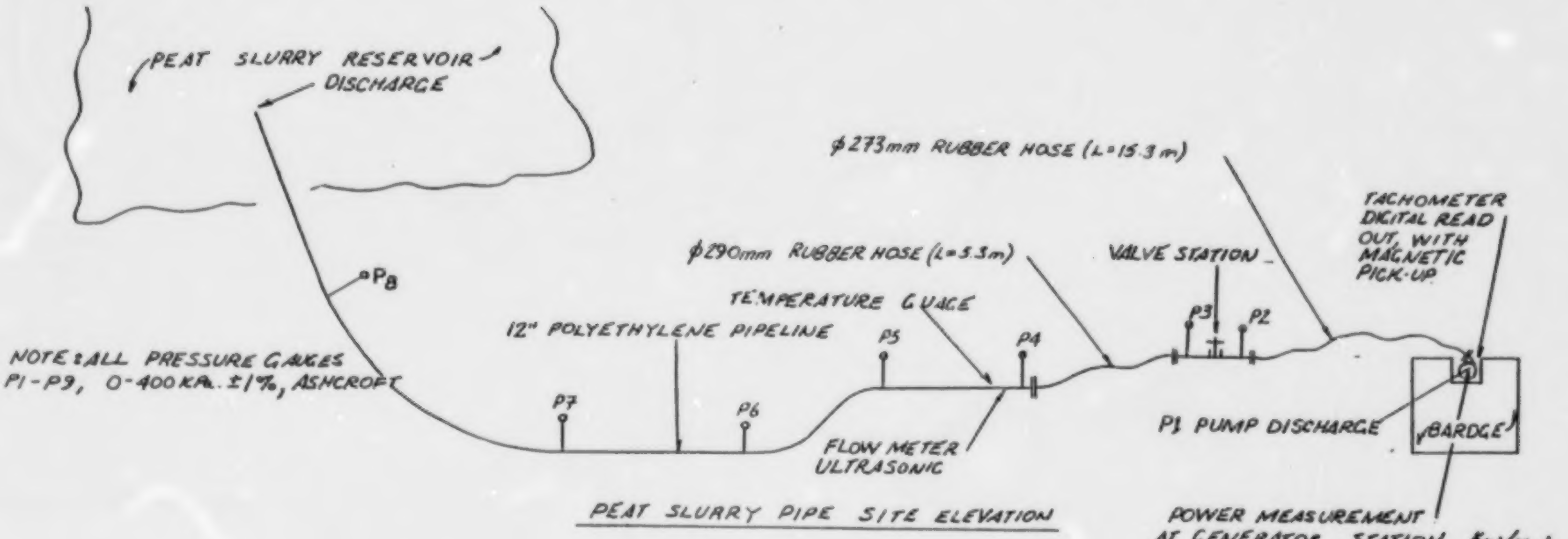

PEAT SLURRY RESERVOIR
DISCHARGE
P8
NOTE: ALL PRESSURE GAUGES
P1-P9, 0-400 KPa. ±1%, ASHCROFT
12" POLYETHYLENE PIPELINE
P7
P6
P5
TEMPERATURE GUAGE
ø290mm RUBBER HOSE (L=5.3m)
P4
FLOW METER
ULTRASONIC
ø273mm RUBBER HOSE (L=15.3 m)
VALVE STATION
P3
P2
TACHOMETER
DIGITAL READ
OUT, WITH
MAGNETIC
PICK-UP
P1 PUMP DISCHARGE
BARDGE
POWER MEASUREMENT
AT GENERATOR STATION Kw/Kwh
PEAT SLURRY PIPE SITE ELEVATION

FIG. #4

For Slurry Test #2, Run #8 (last eight measurements), Water Test #3 (three last measurements) and Water Test #4

The Pipeline Length Total = 250.2 m

Expander ø8"/10" & Flanch, length = 0.8 m
Rubber hose, ins. ø273 mm = 15.3
Valve skid, ins. ø230 mm,length = 5.8 m
Expander ø10"/12" & flanch,length = 0.8 m
Rubber hose, ins. ø290 mm, length = 5.3 m
12 polyethylene pipeline, length = 222.2 m
TOTAL = 250.2 m

Pipeline Distance Between Gauges:

P1 - P2 = 18 m
P2 - P3 = 3.15 m
P3 - P4 = 8.5 m
P4 - P5 = 100 m
P5 - P6 = 49.4 m
P6 - P7 = 42.6 m
P7 - P8 = 20.6 m
P8 to end of pipe = 8.15 m

FIGURE 5-4

Slurry Pipeline Layout for Tests 2, Run 8 (last part)

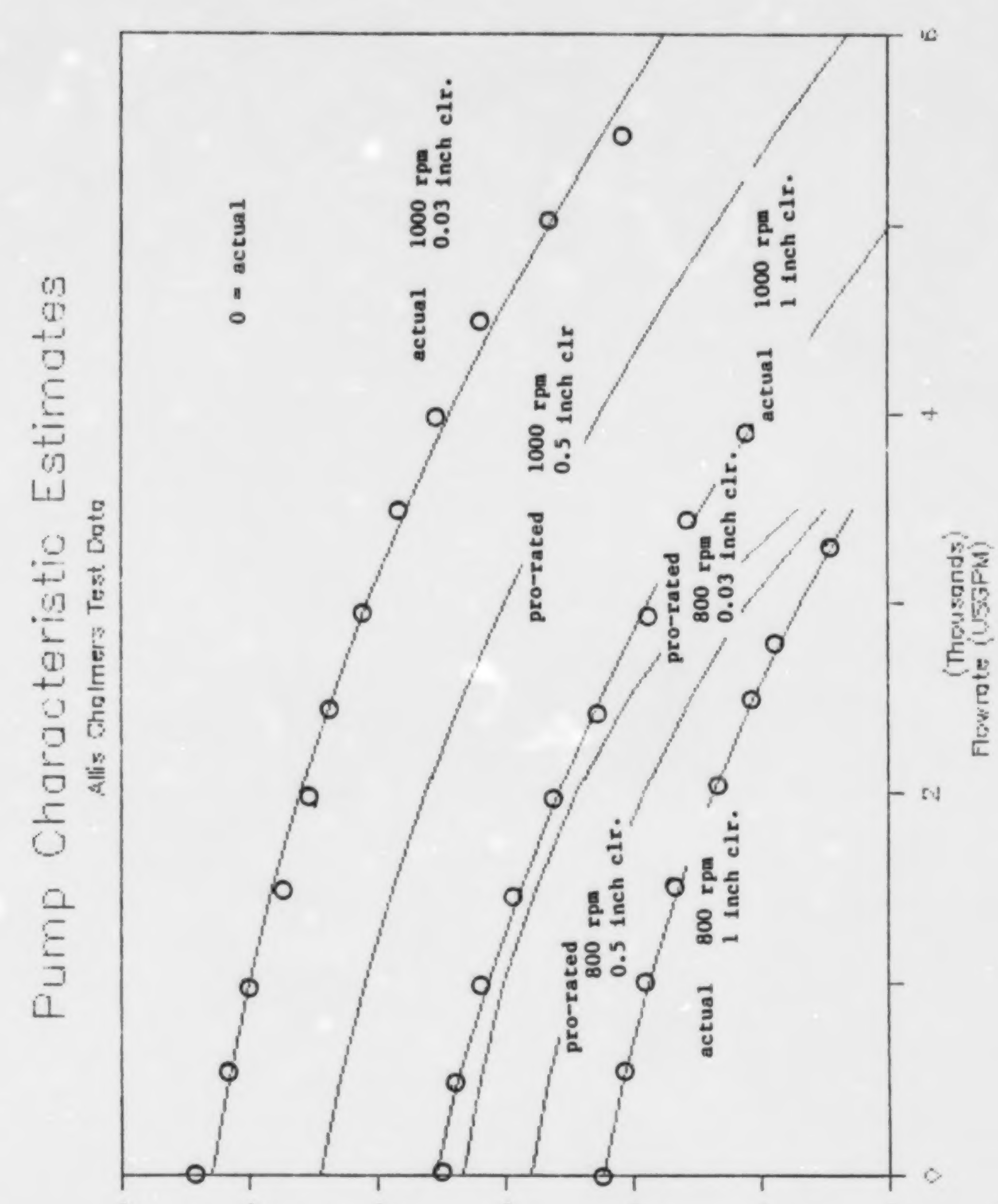

Pump Characteristic Estimates
Allis Chalmers Test Data
0 = actual
actual 1000 rpm 0.03 inch clr.
pro-rated 1000 rpm 0.5 inch clr
actual 1000 rpm 1 inch clr.
pro-rated 800 rpm 0.03 inch clr.
pro-rated 800 rpm 0.5 inch clr.
actual 800 rpm 1 inch clr.
Pump Head (m)
60
50
40
30
20
10
0
0
2
4
6
(Thousands)
Flowrate (USGPM)

FIGURE 5-5

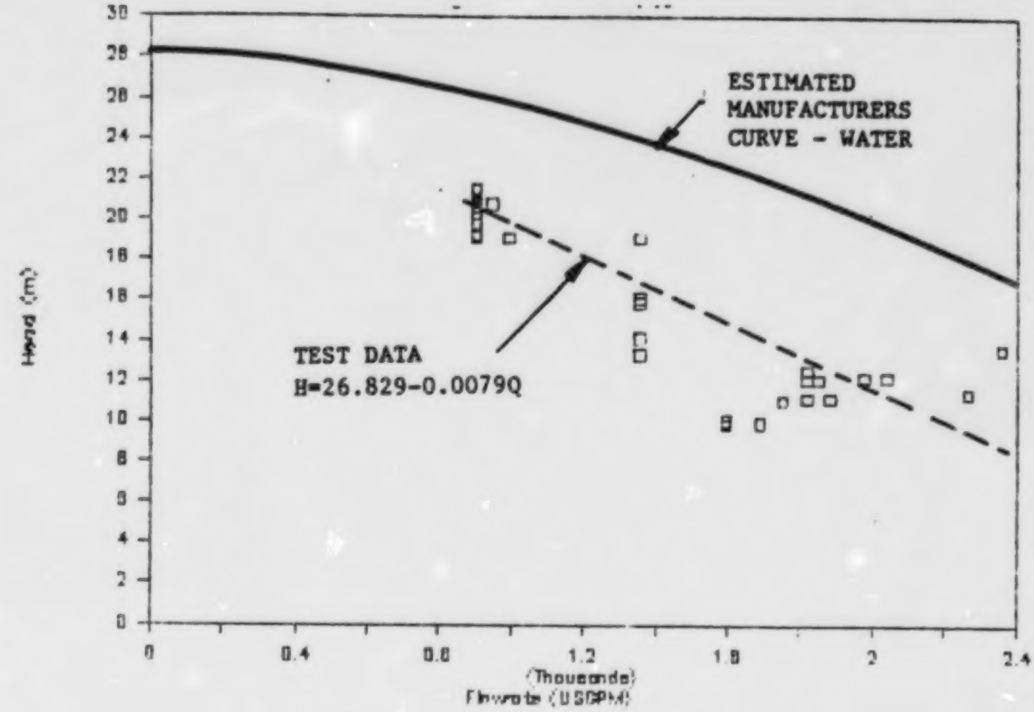


Figure 5-6 - Pump Characteristic, 800 RPM, 0.5 in
Average Solids Content 1.43%

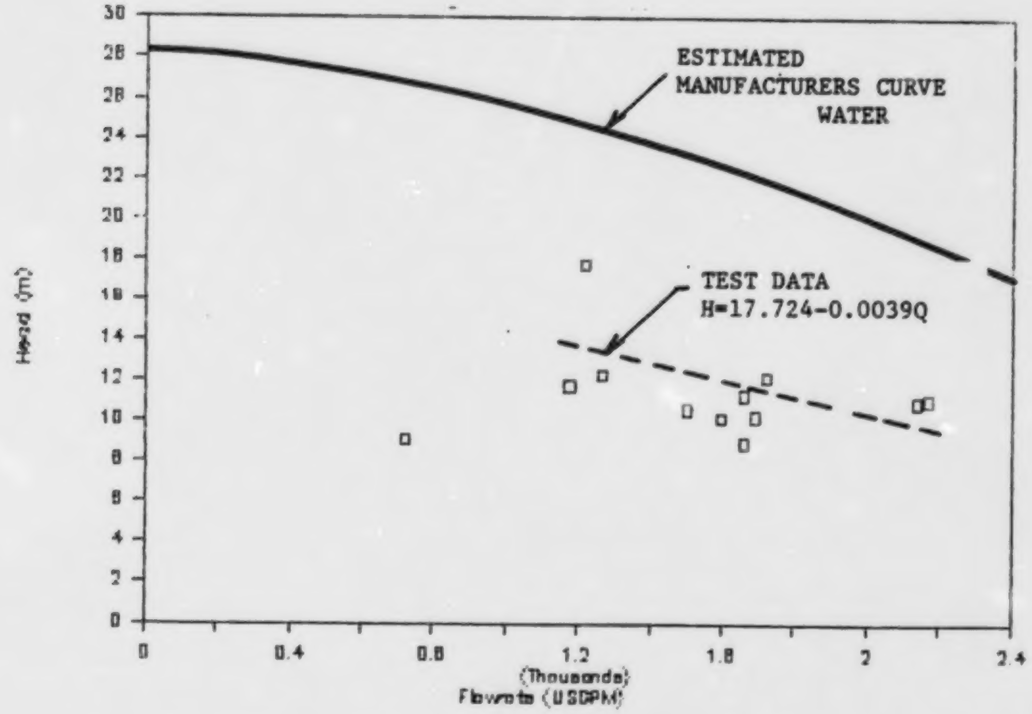


Figure 5-7 - Pump Characteristic, 800 RPM, 0.5 in
Average Solids Content 2.82%

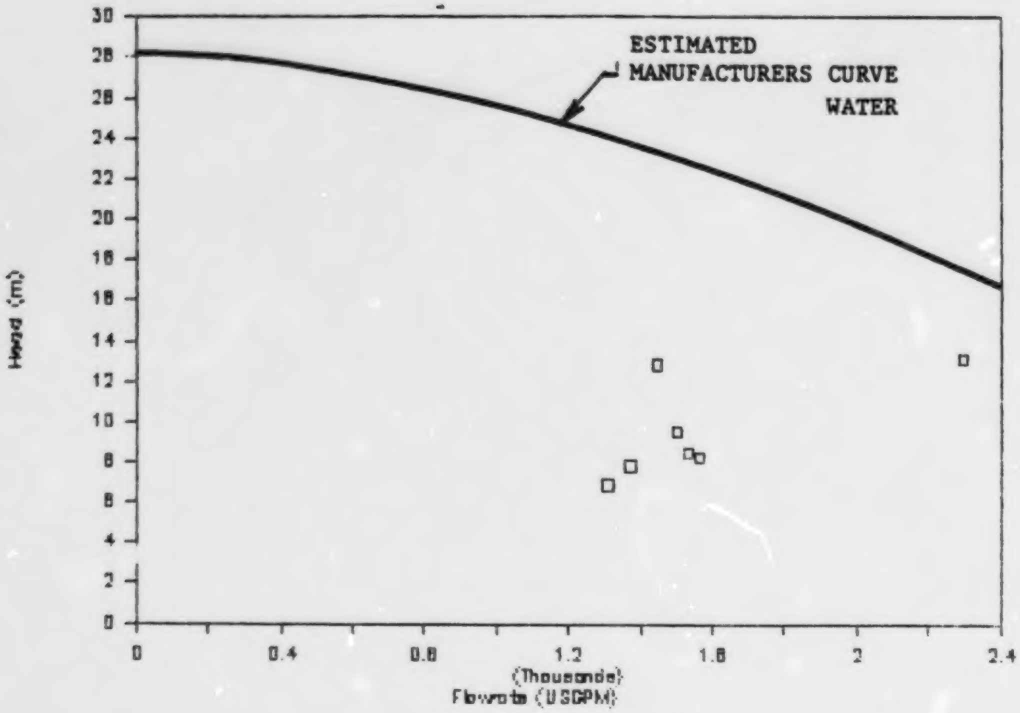


Figure 5-8 - Pump Characteristic, 800 RPM, 0.5 in Average Solids Content 4.18%

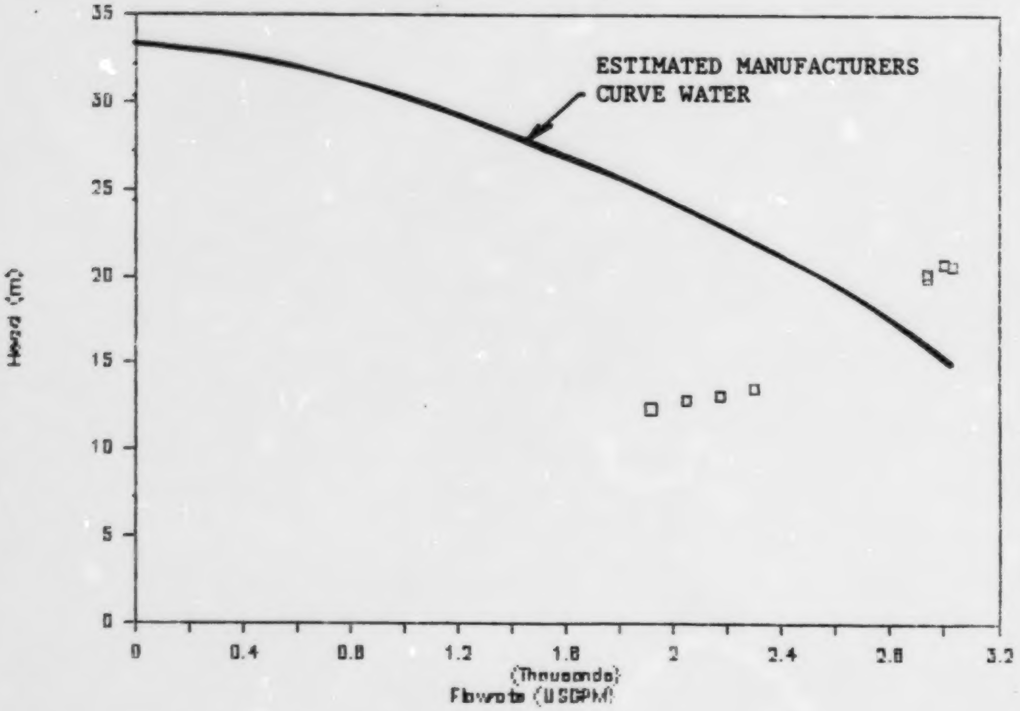


Figure 5-9 - Pump Characteristic, 800 RPM, 0.03 in Average Solids Content 0.70%

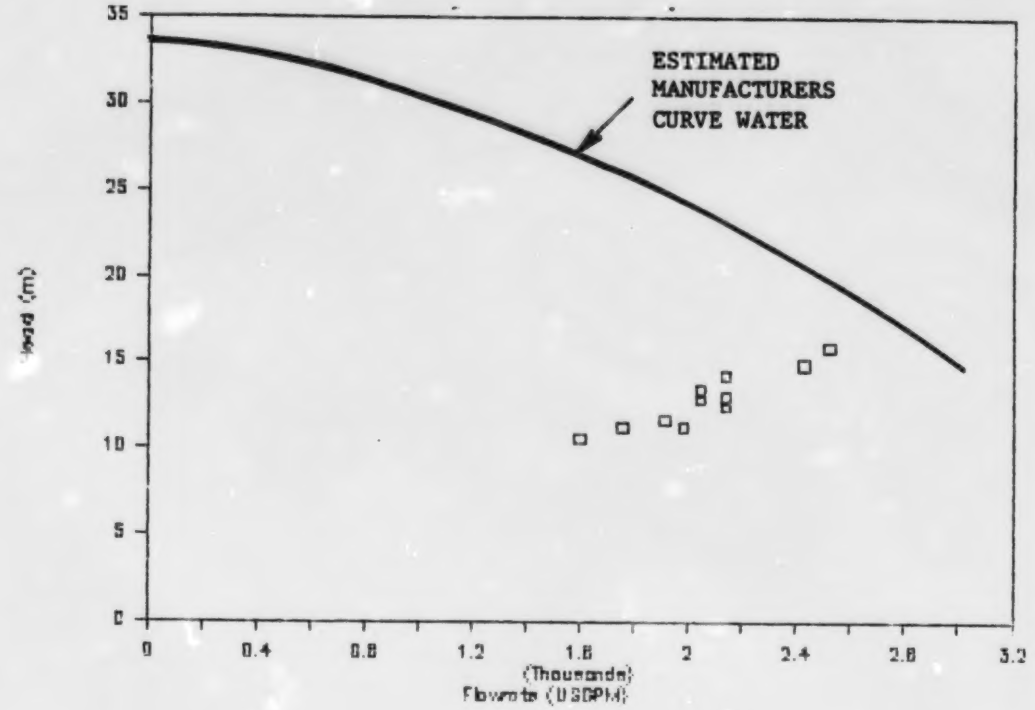


Figure 5-10 - Pump Characteristic, 800 RPM, 0.03 in
Average Solids Content 3.24%

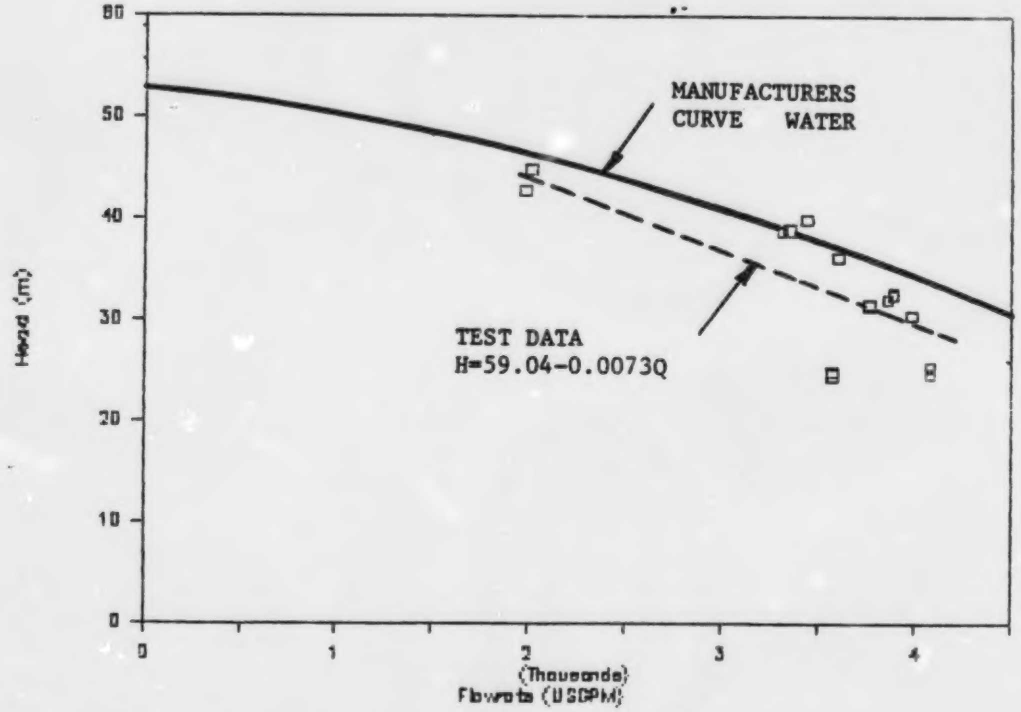


Figure 5-11 - Pump Characteristic, 1000 RPM, 0.03 in
Average Solids Content 0.0%

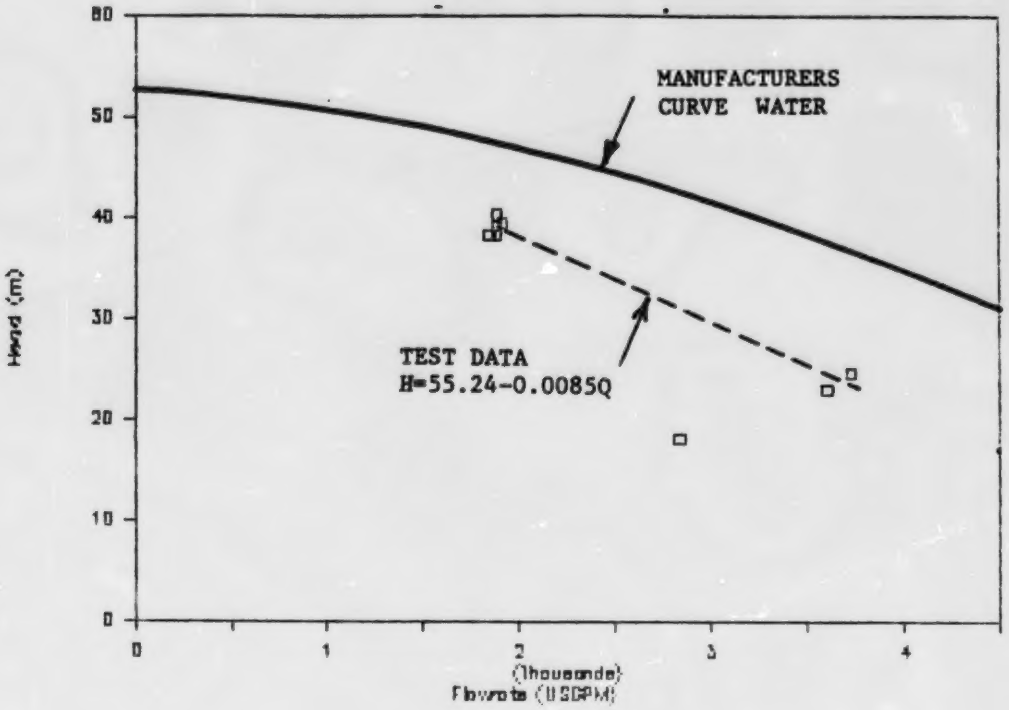


Figure 5-12 - Pump Characteristic, 1000 RPM, 0.03 in
Average Solids Content 0.70%

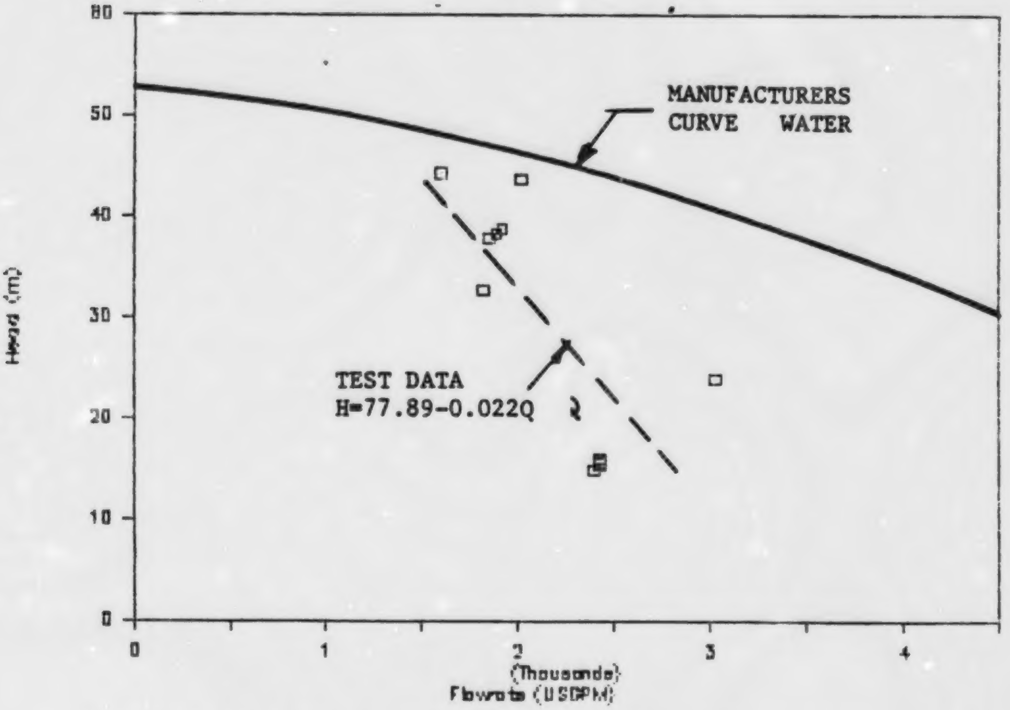


Figure 5-13 - Pump Characteristic, 1000 RPM, 0.03 in
Average Solids Content 1.52%

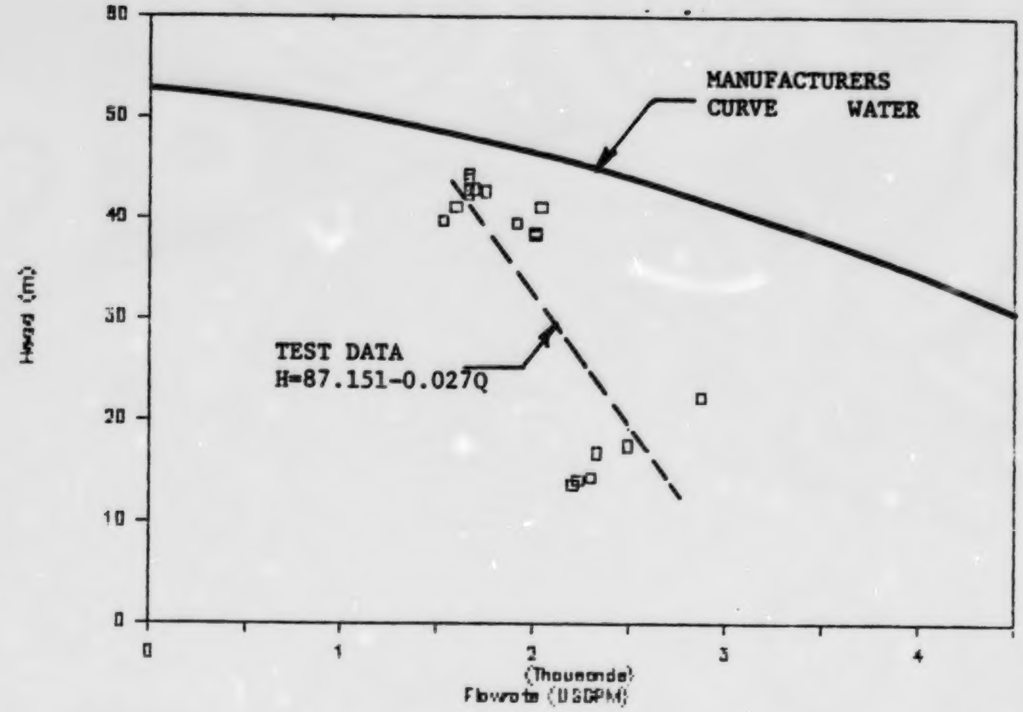


Figure 5-14 - Pump Characteristic, 1000 RPM, 0.03 in
Average Solids Content 2.56%

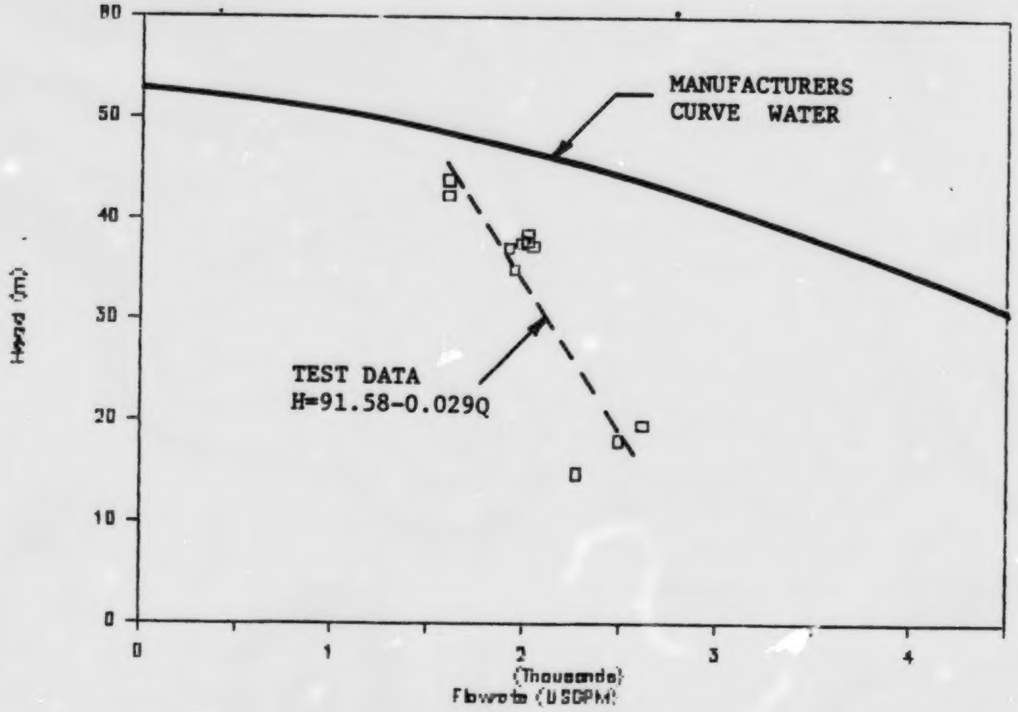


Figure 5-15 - Pump Characteristic, 1000 RPM, 0.03 in
Average Solids Content 3.45%

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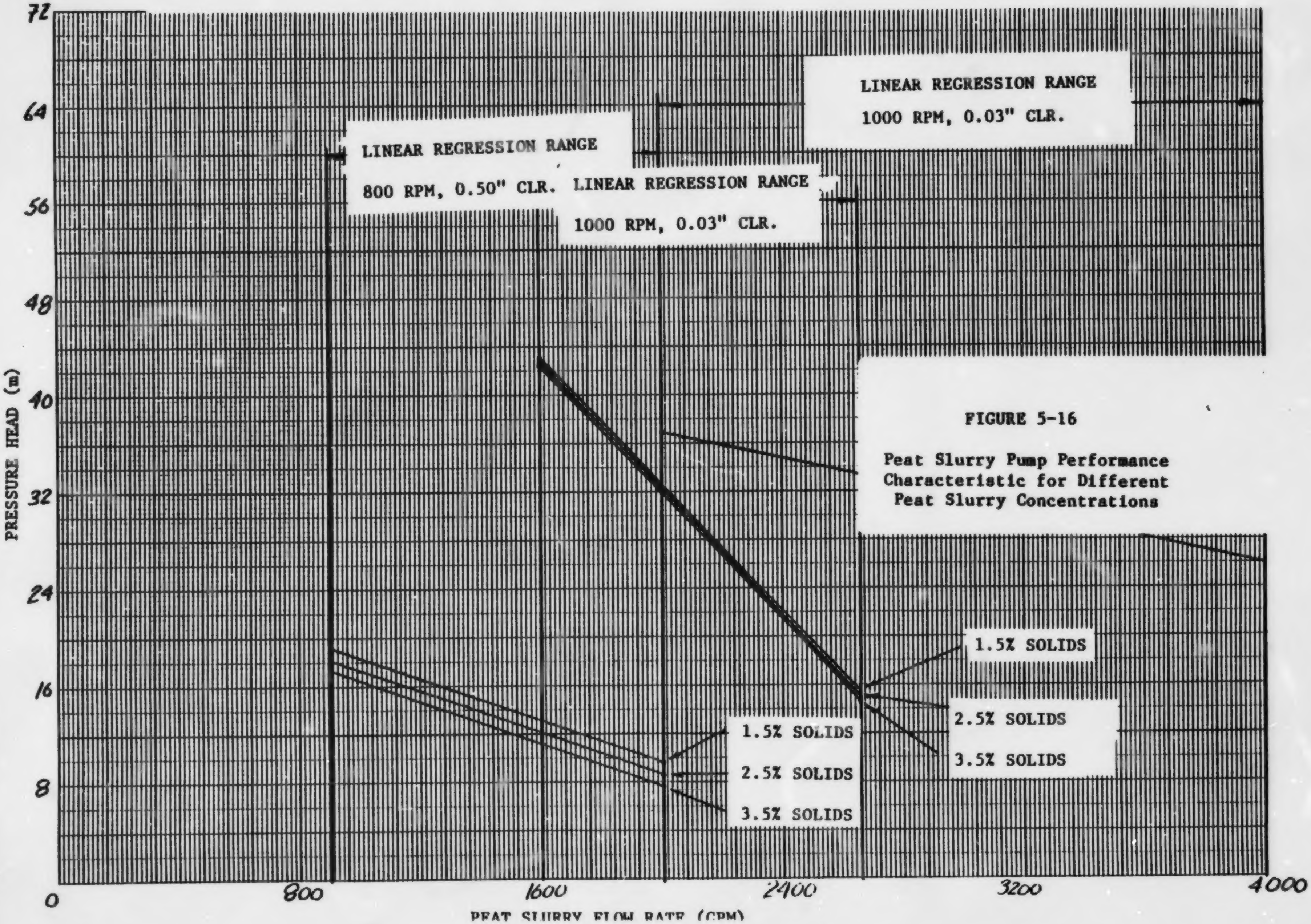


FIGURE 5-16

Peat Slurry Pump Performance Characteristic for Different Peat Slurry Concentrations

FIGURE 5-17

Pump Power Demand, 800 RPM, 0.5 in

Water Power & Brake Power

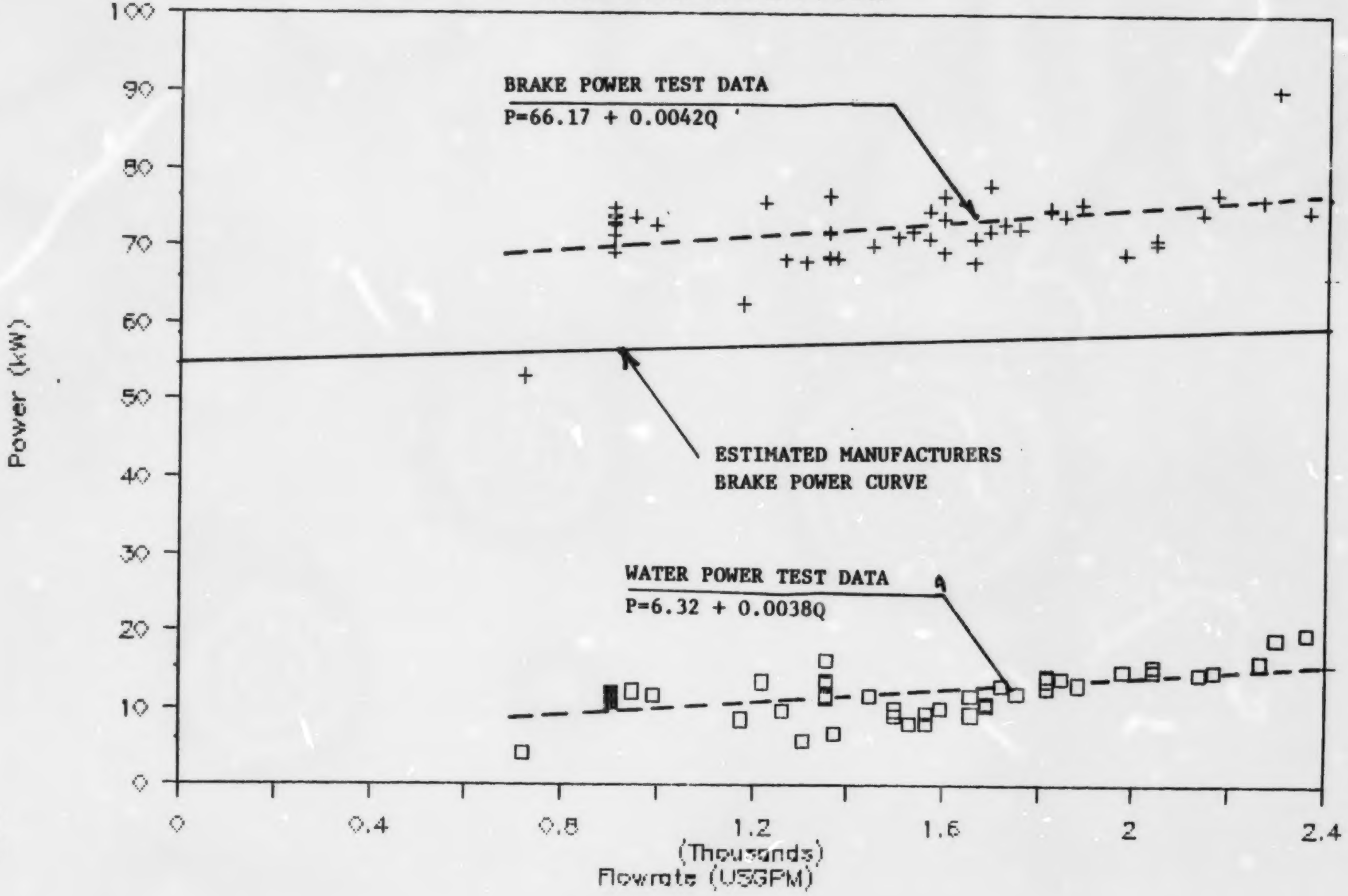


FIGURE 5-18

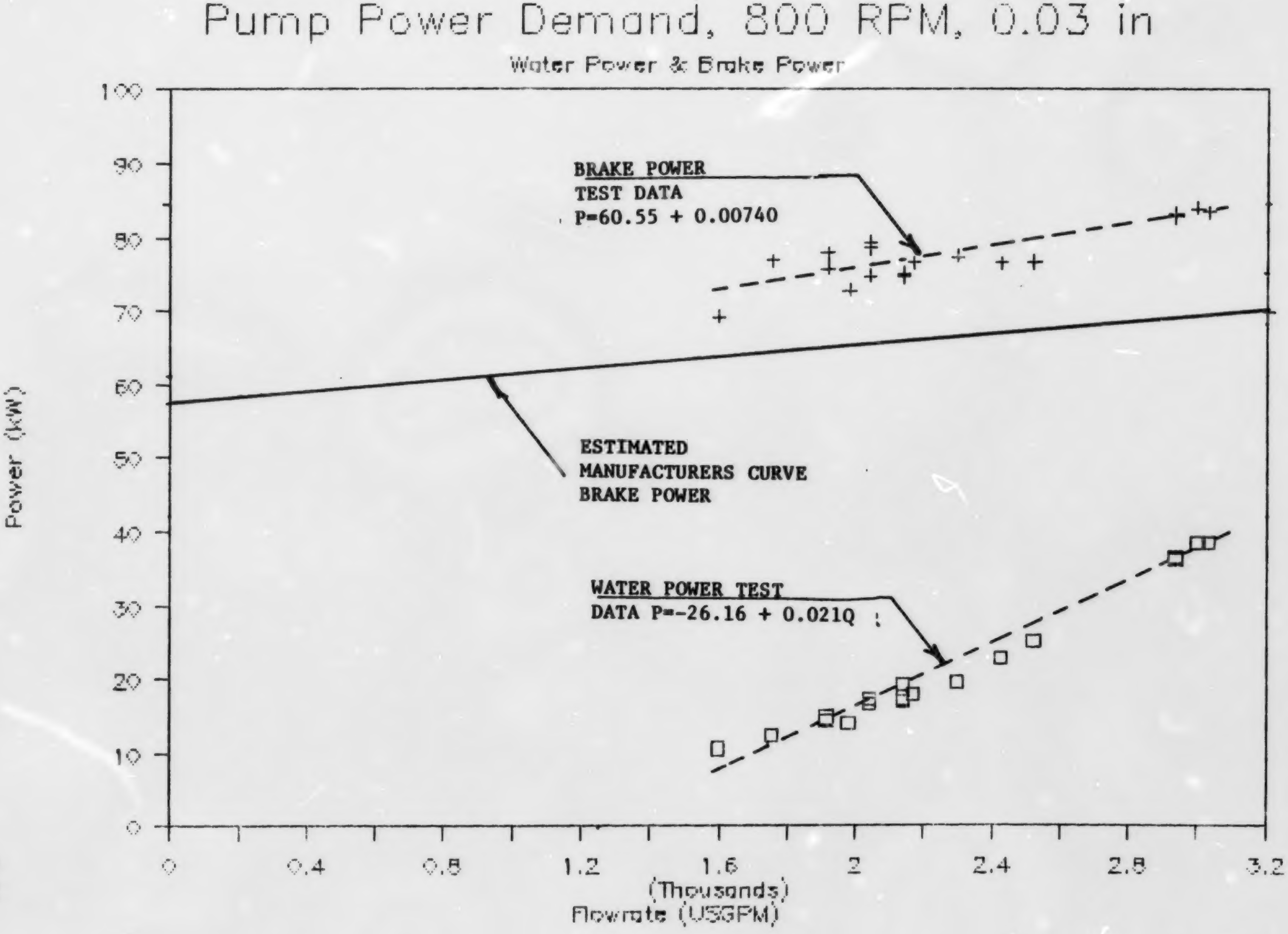

Pump Power Demand, 800 RPM, 0.03 in
Water Power & Brake Power
BRAKE POWER
TEST DATA
P=60.55 + 0.00740
ESTIMATED
MANUFACTURERS CURVE
BRAKE POWER
WATER POWER TEST
DATA P=-26.16 + 0.021Q
Power (kW)
100
90
80
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
(Thousands)
Flowrate (USGPM)

FIGURE 5-19

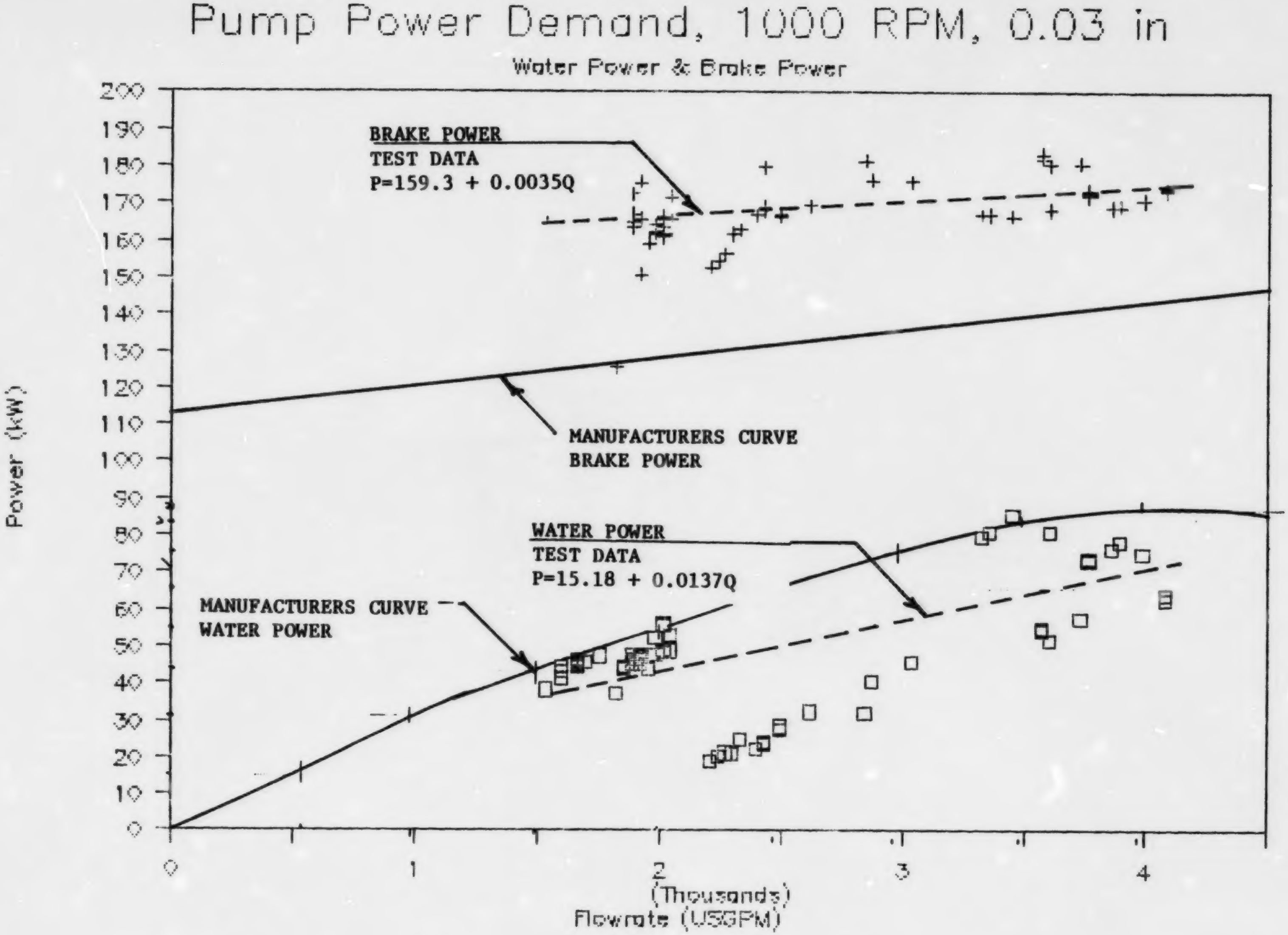

Pump Power Demand, 1000 RPM, 0.03 in
Water Power & Brake Power
Power (kW)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
BRAKE POWER
TEST DATA
P=159.3 + 0.0035Q
MANUFACTURERS CURVE
BRAKE POWER
WATER POWER
TEST DATA
P=15.18 + 0.0137Q
MANUFACTURERS CURVE
WATER POWER
0
1
2
3
4
(Thousands)
Flowrate (USGPM)

FIGURE 5-20

Pump Power Demand Estimates

Allis Chalmers Test Data

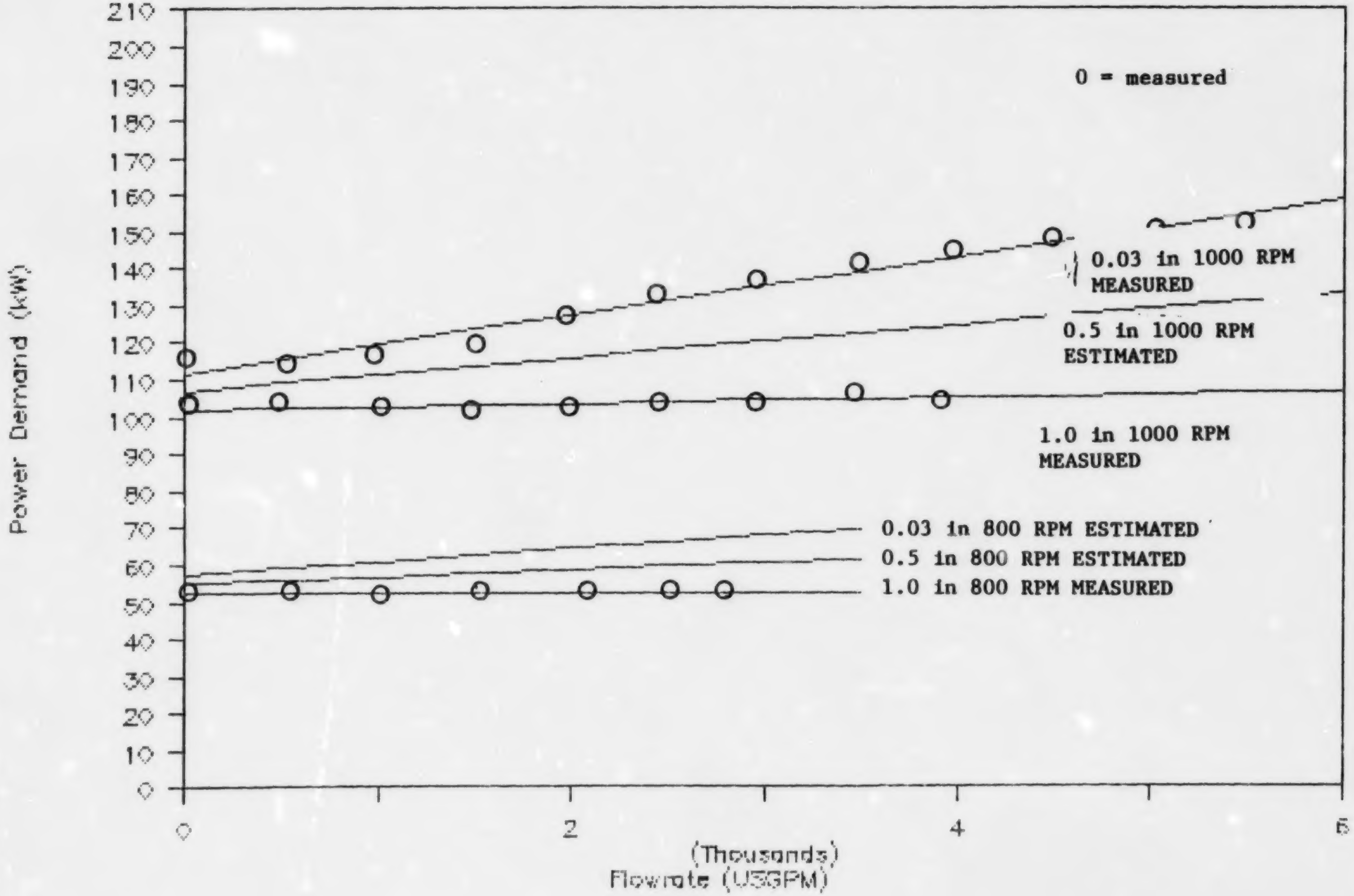


FIGURE 5-21

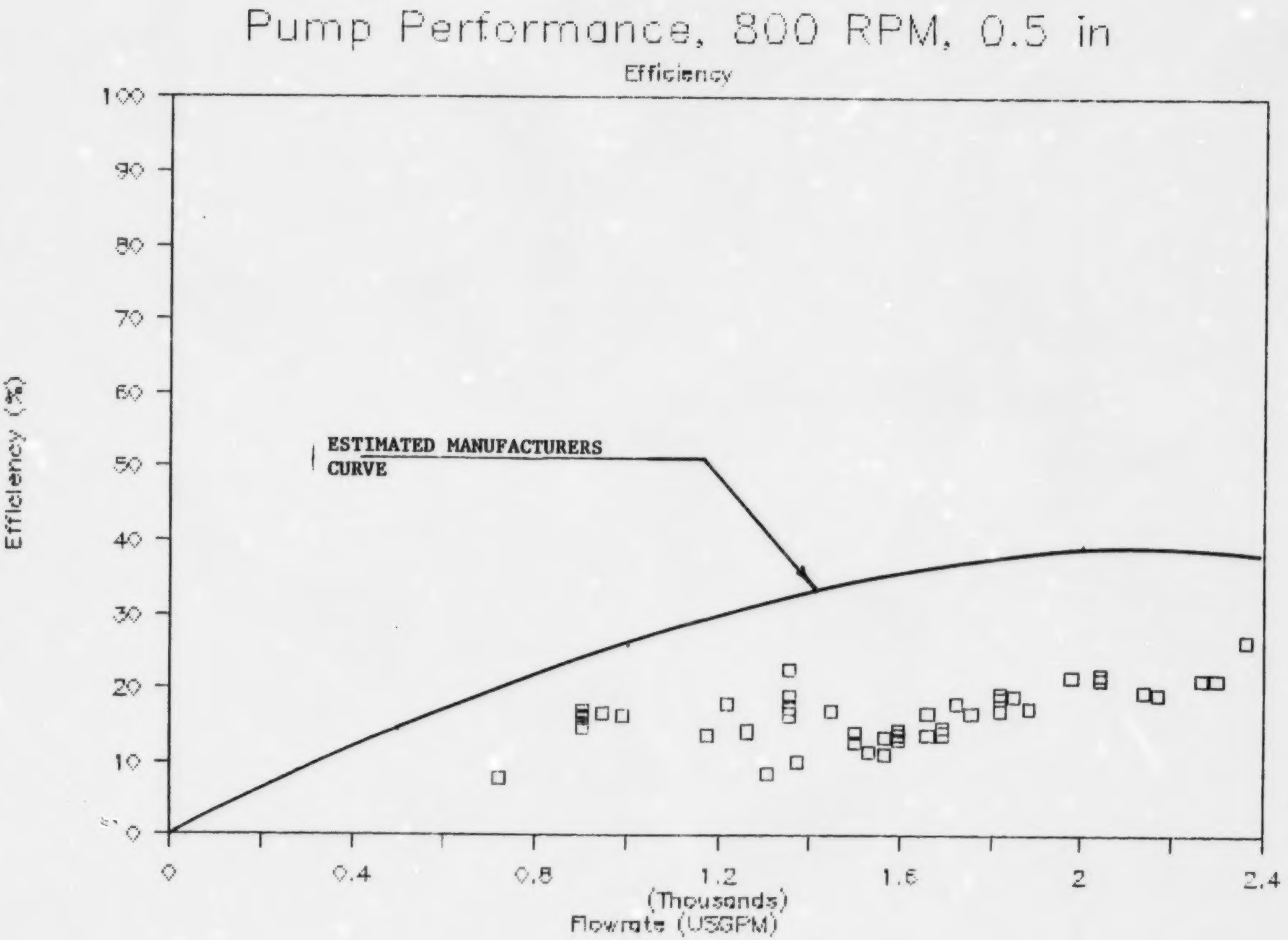

Pump Performance, 800 RPM, 0.5 in
Efficiency
Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
(Thousands)
Flowrate (USGPM)
ESTIMATED MANUFACTURERS CURVE

FIGURE 5-22

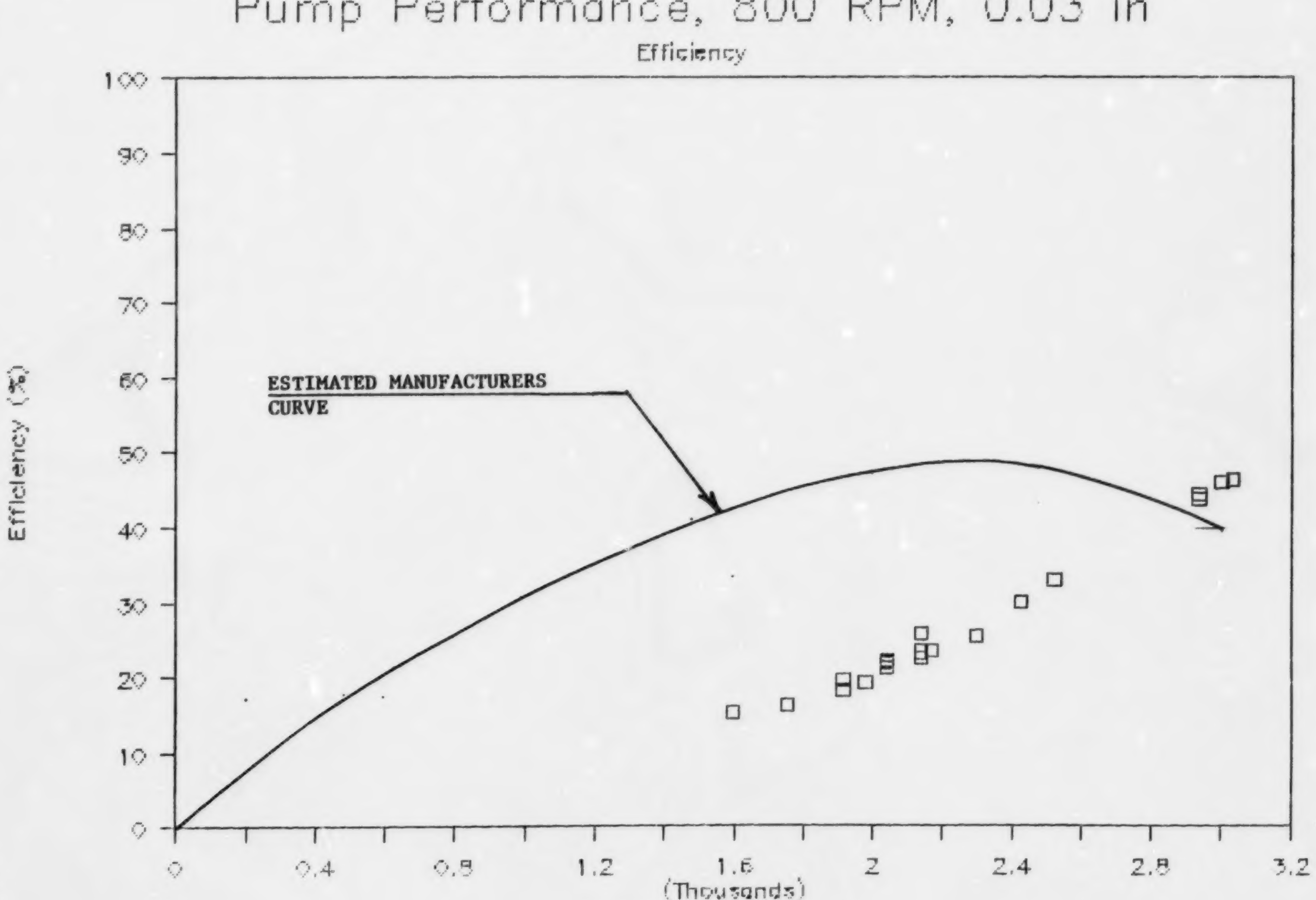
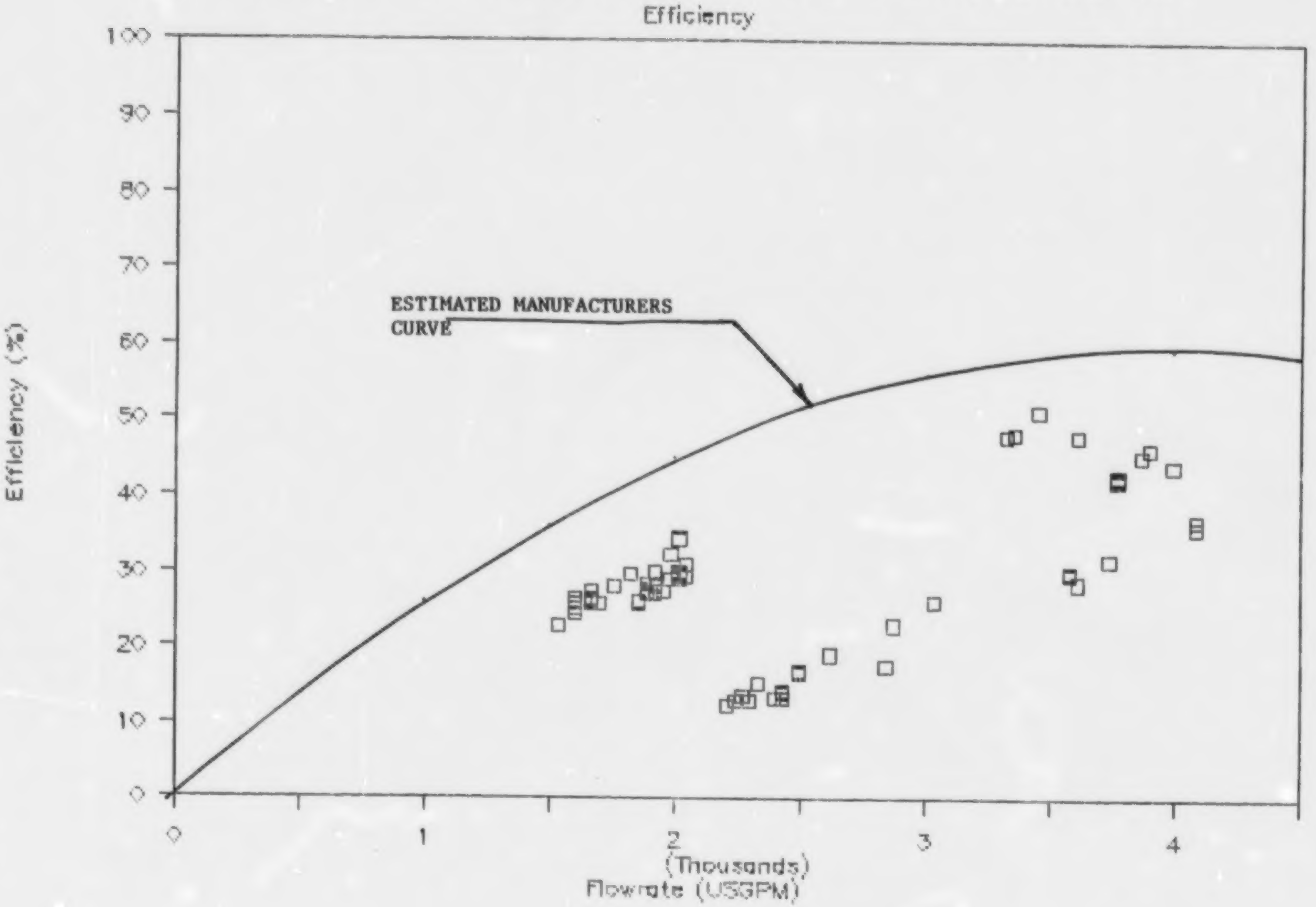

Pump Performance, 800 RPM, 0.03 in
Efficiency
ESTIMATED MANUFACTURERS CURVE
Efficiency (%)
100
90
80
70
60
50
40
30
20
10
0
0
0.4
0.8
1.2
1.6
2
2.4
2.8
3.2
(Thousands)
Flowrate (USGPM)

FIGURE 5-23



Pump Performance, 1000 RPM, 0.03 in

FIGURE 5 - 24

Viscosity vs Concentration

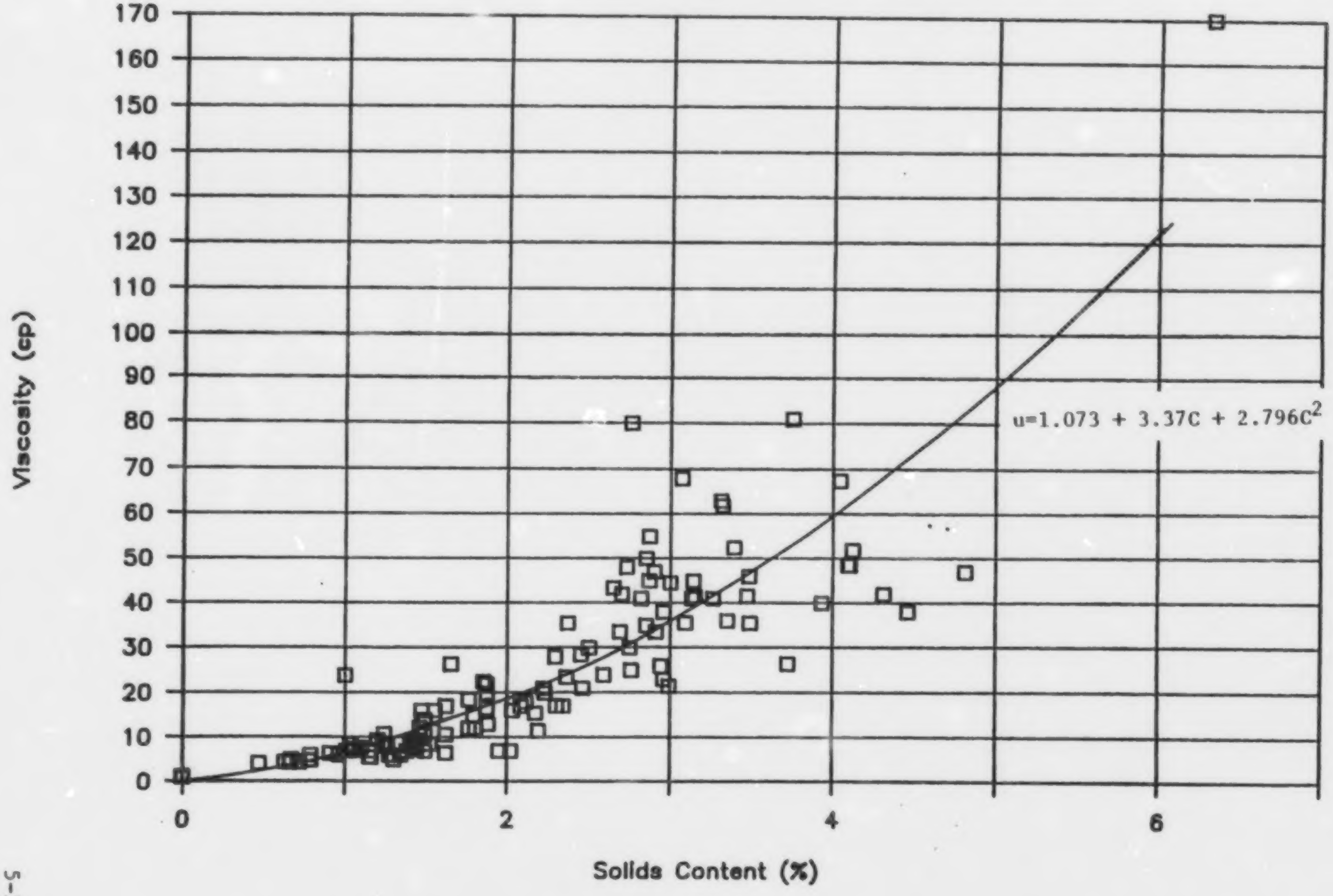
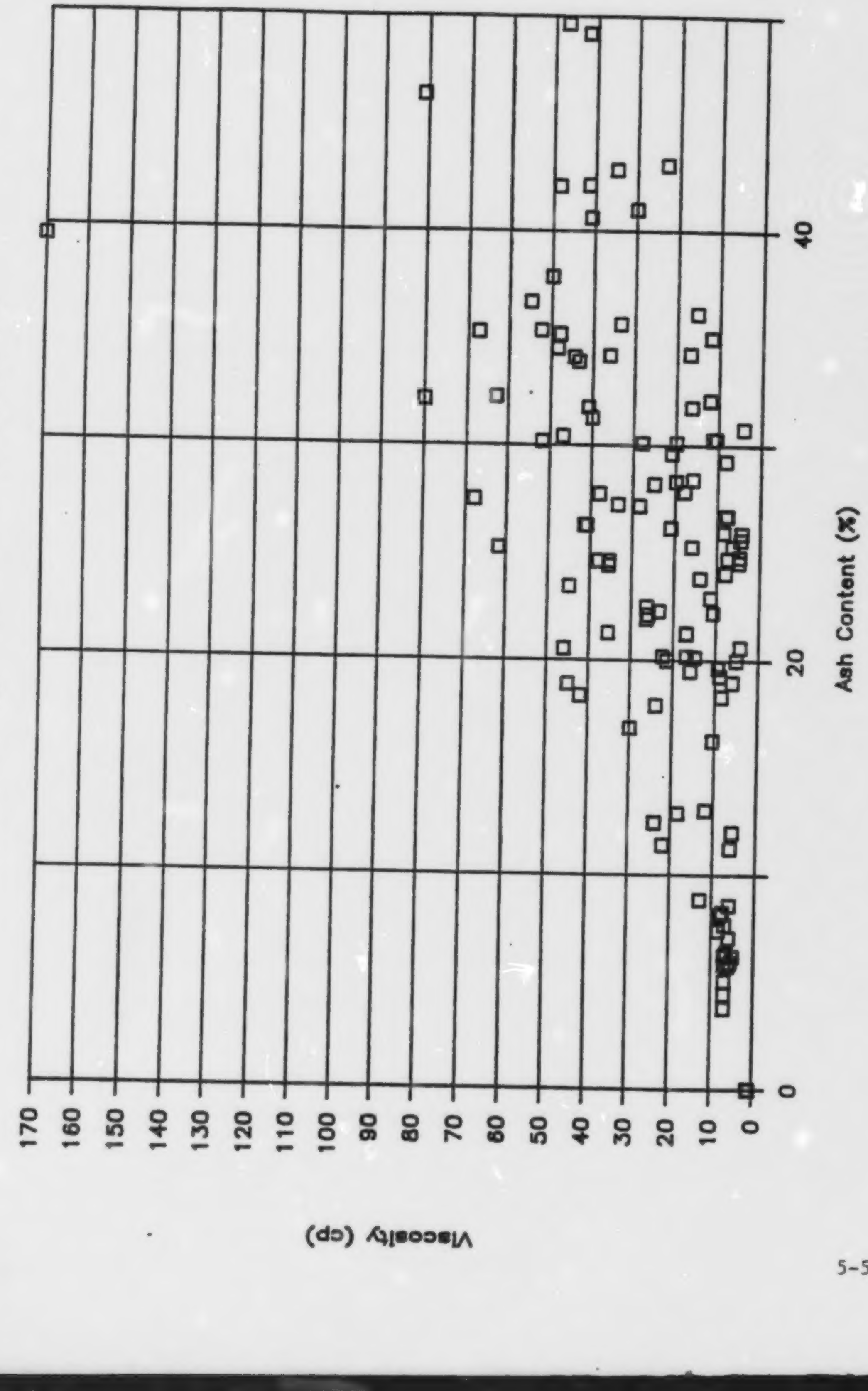


FIGURE 5-25

Viscosity vs Ash Content



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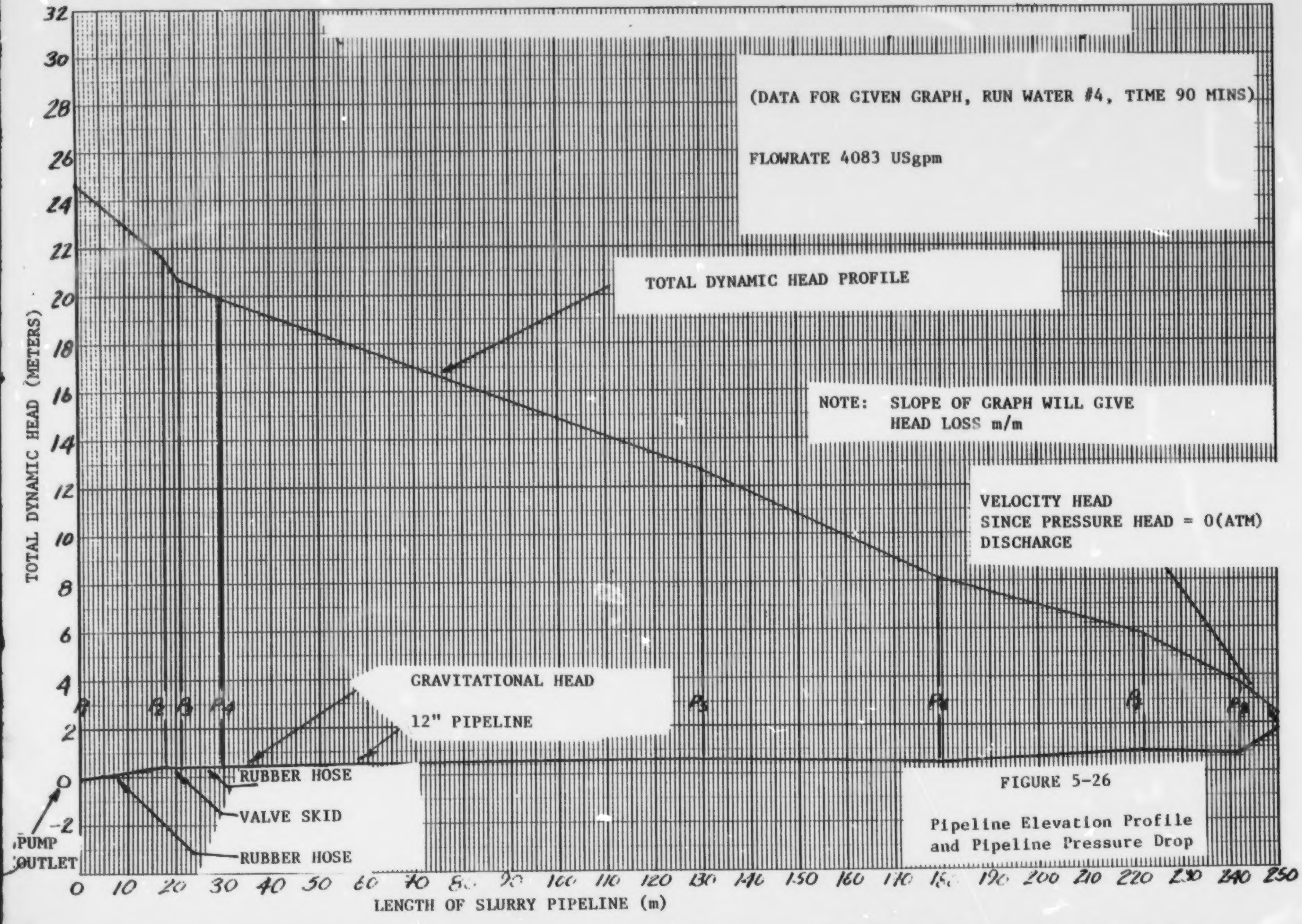

(DATA FOR GIVEN GRAPH, RUN WATER #4, TIME 90 MINS)

FLOWRATE 4083 USgpm

NOTE: SLOPE OF GRAPH WILL GIVE HEAD LOSS m/m

VELOCITY HEAD
SINCE PRESSURE HEAD = 0(ATM)
DISCHARGE

FIGURE 5-26

Pipeline Elevation Profile and Pipeline Pressure Drop

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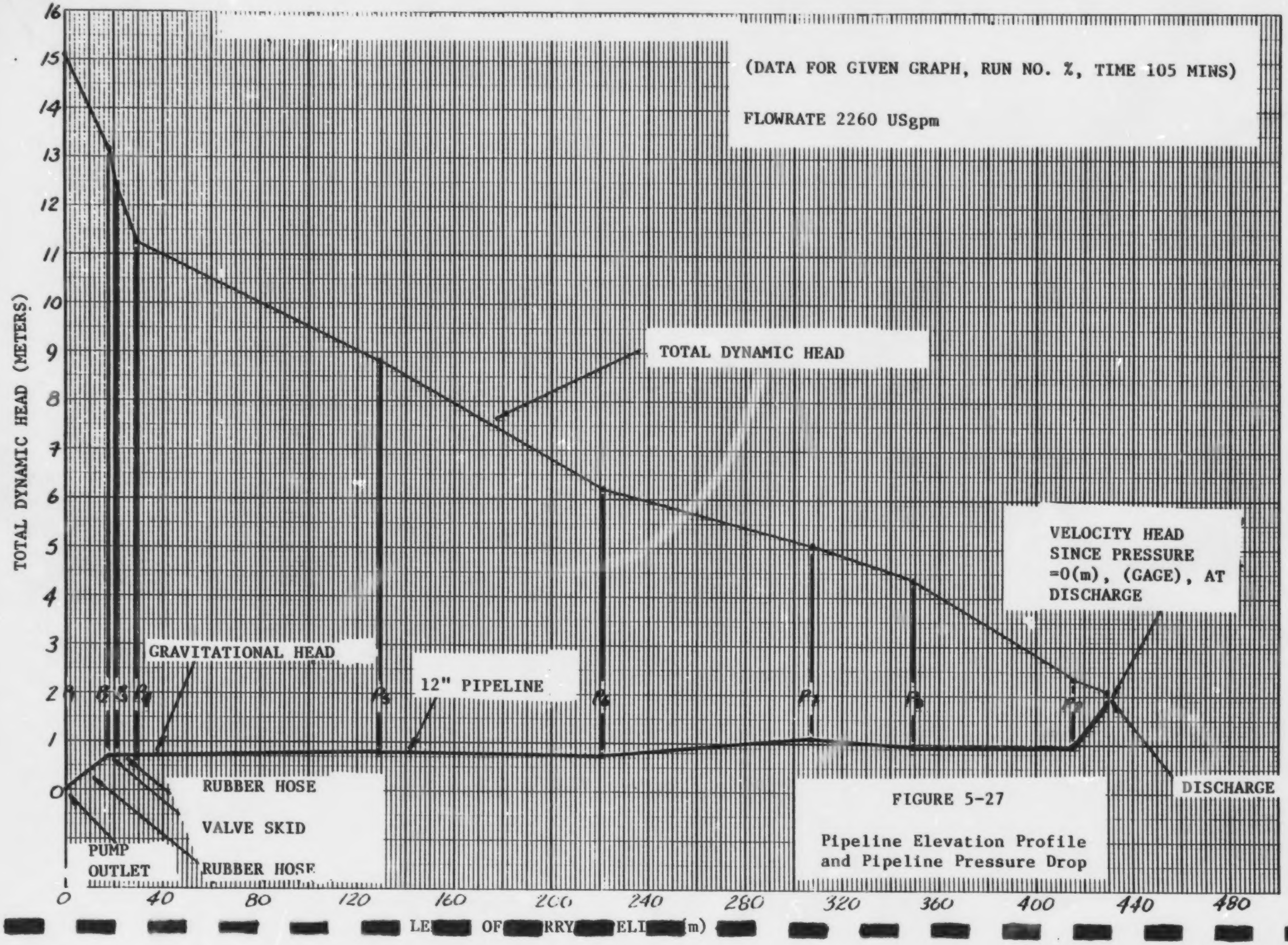


FIGURE 5-27

Pipeline Elevation Profile and Pipeline Pressure Drop

FIGURE 5-28

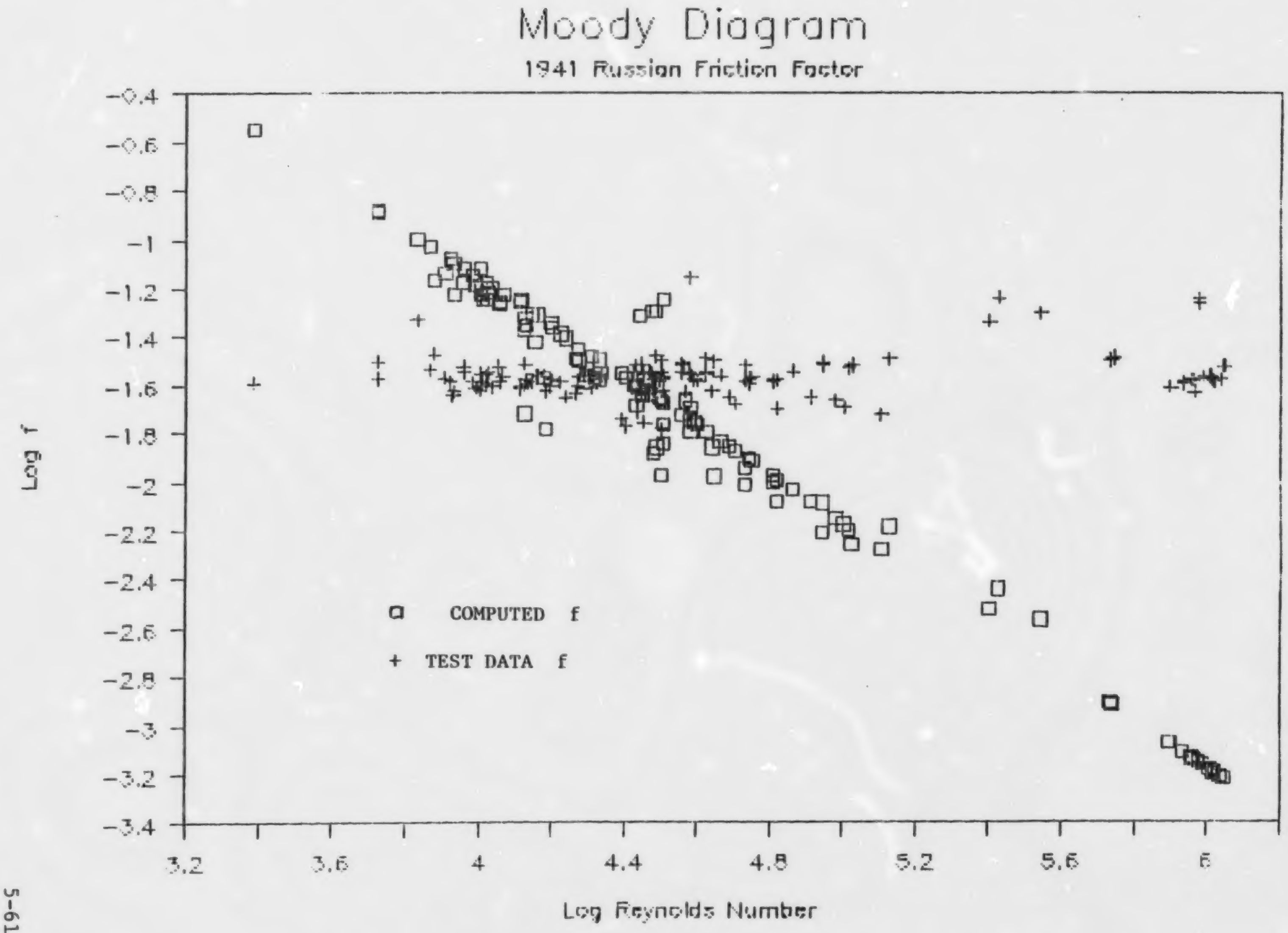

Moody Diagram
1941 Russian Friction Factor
Log f
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
-2.6
-2.8
-3
-3.2
-3.4
3.2
3.6
4
4.4
4.8
5.2
5.6
6
Log Reynolds Number
□ COMPUTED f
+ TEST DATA f

FIGURE 5-29

1941 Russian Friction Factor

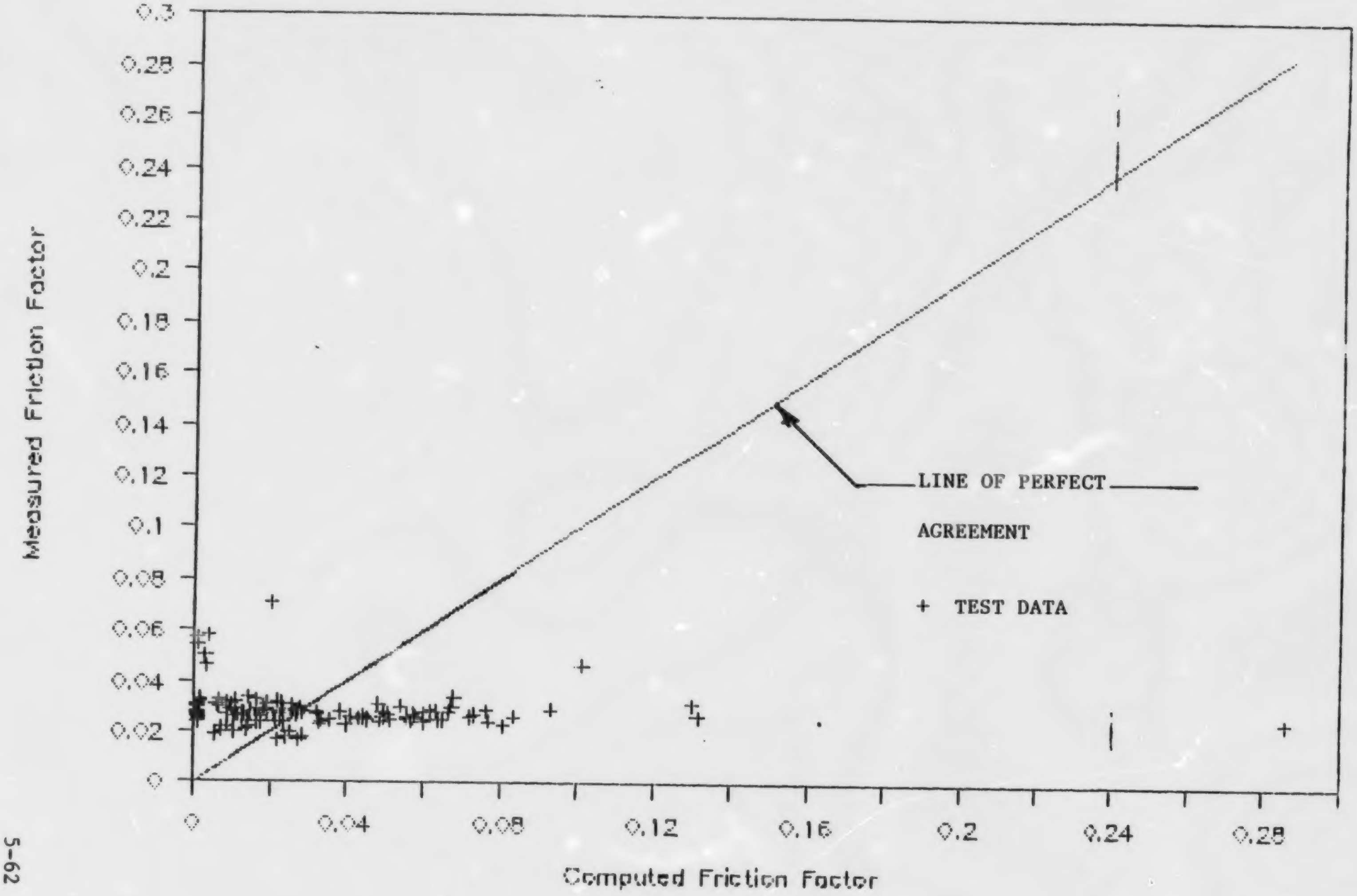


FIGURE 5-30

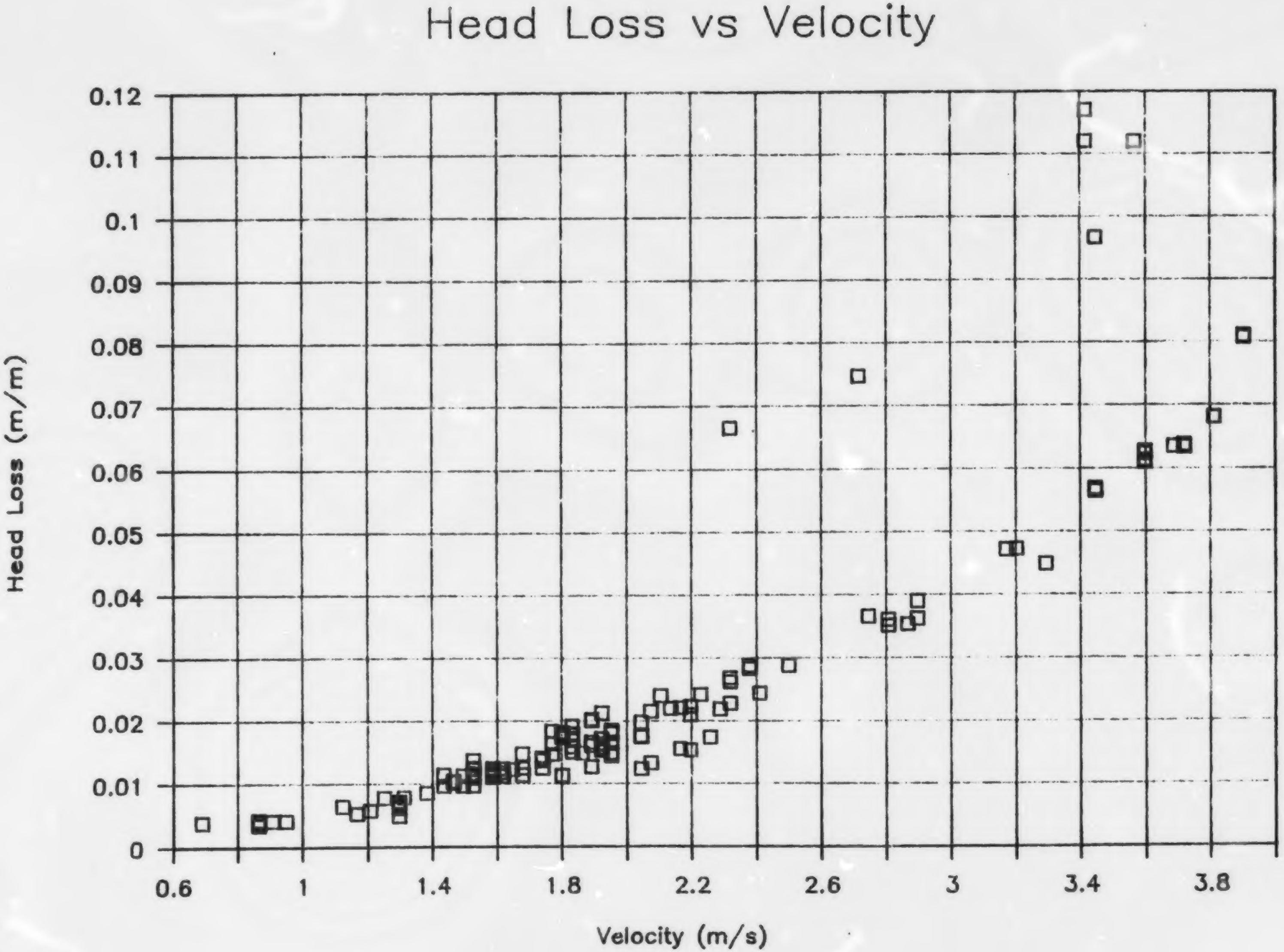

Head Loss vs Velocity
Head Loss (m/m)
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0.6
1
1.4
1.8
2.2
2.6
3
3.4
3.8
Velocity (m/s)

FIGURE 5-31

Solids Content vs Head Loss

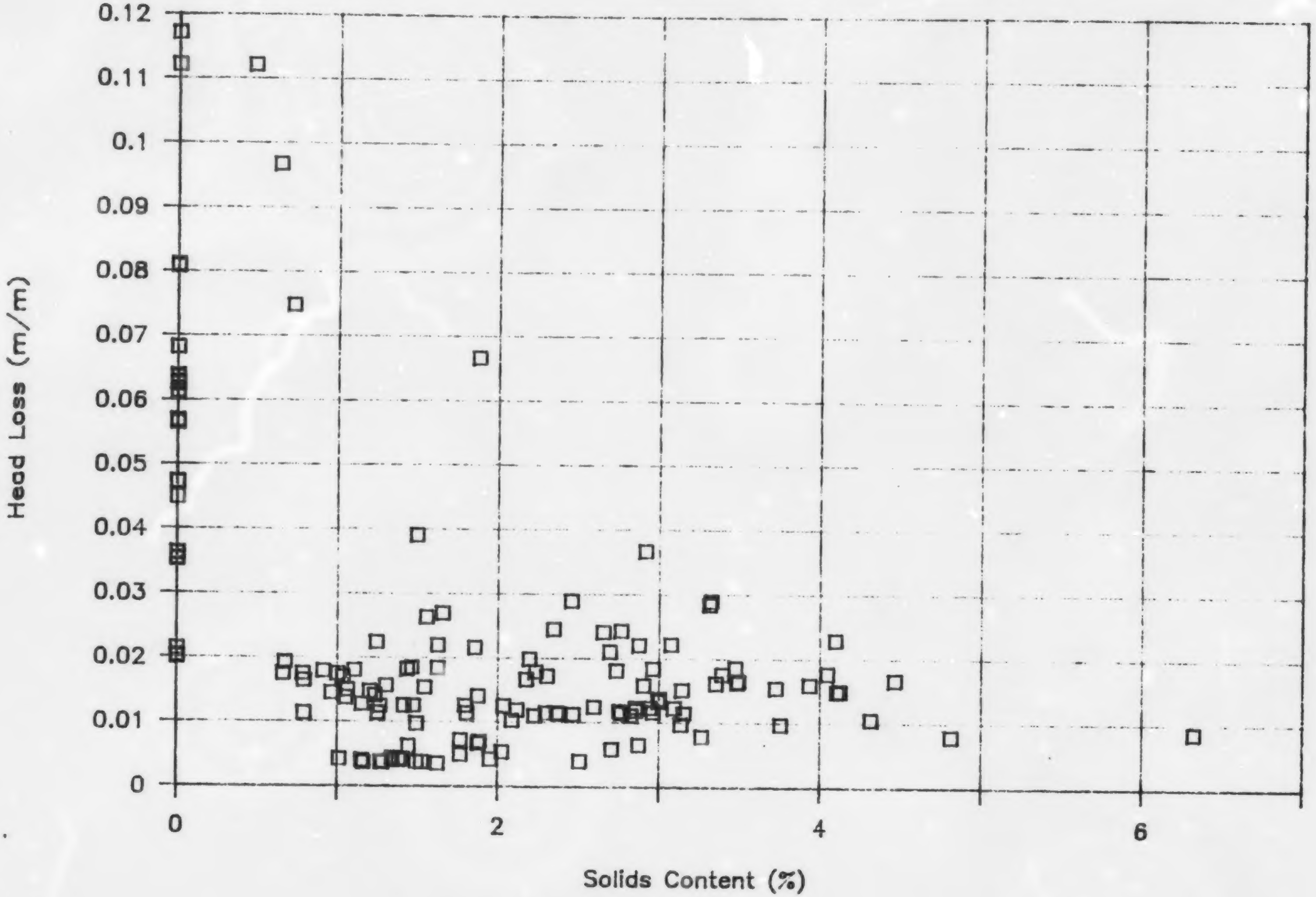


FIGURE 5-32

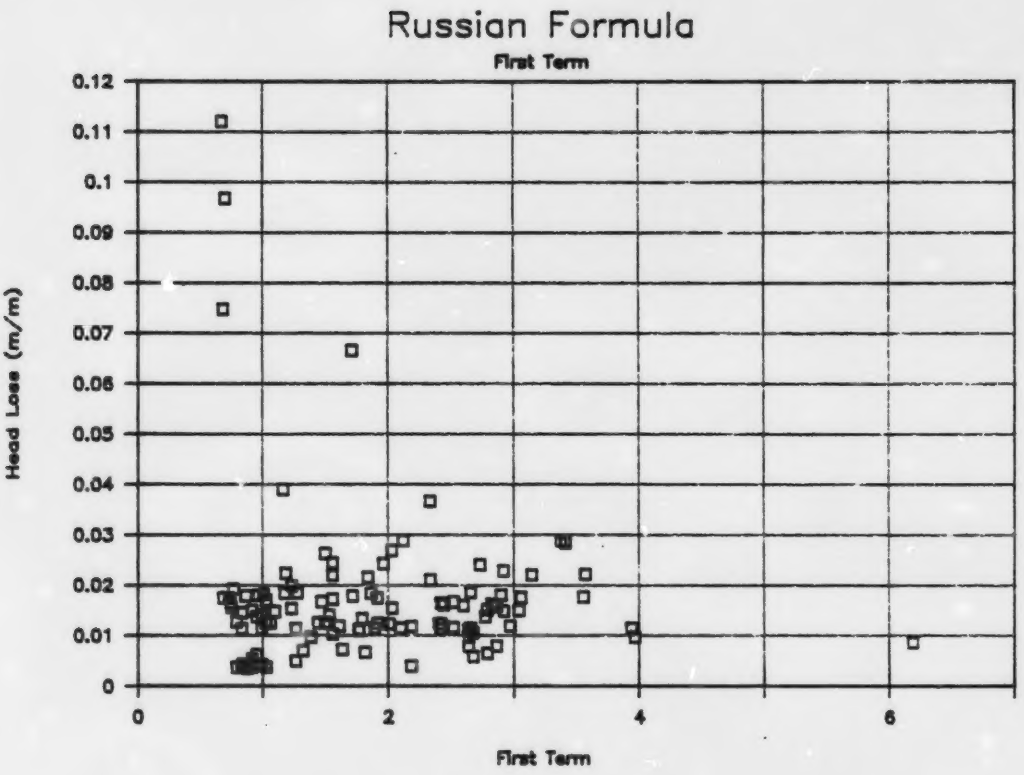


FIGURE 5-33

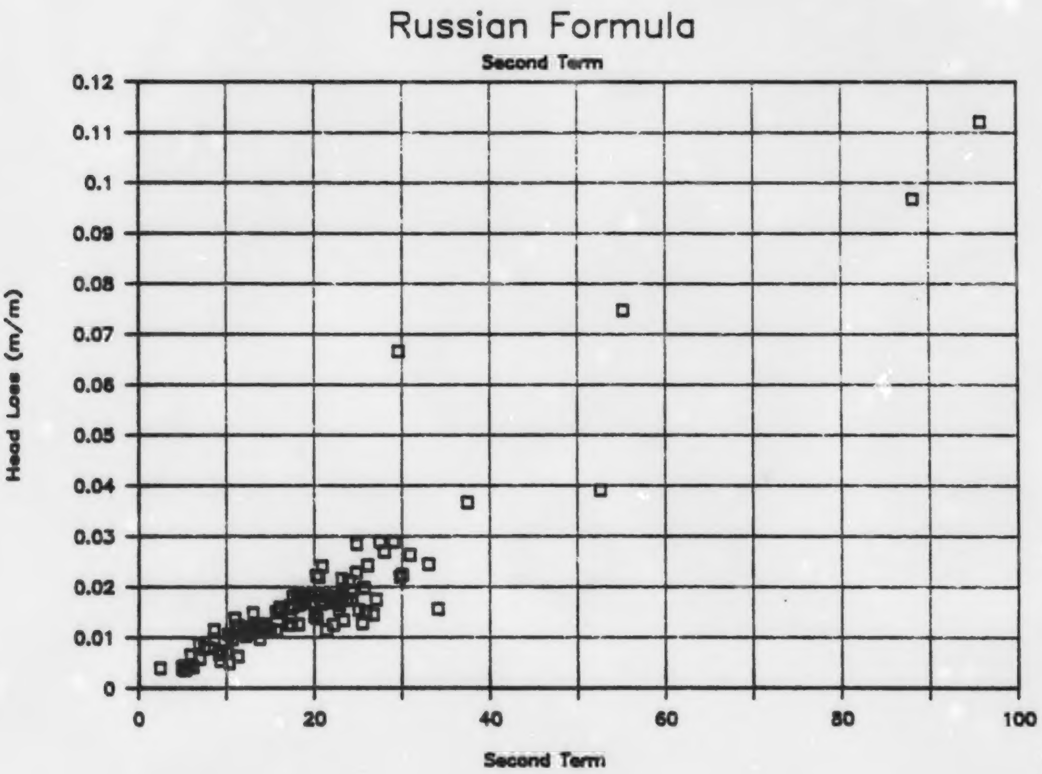


FIGURE 5-34

Russian Formula

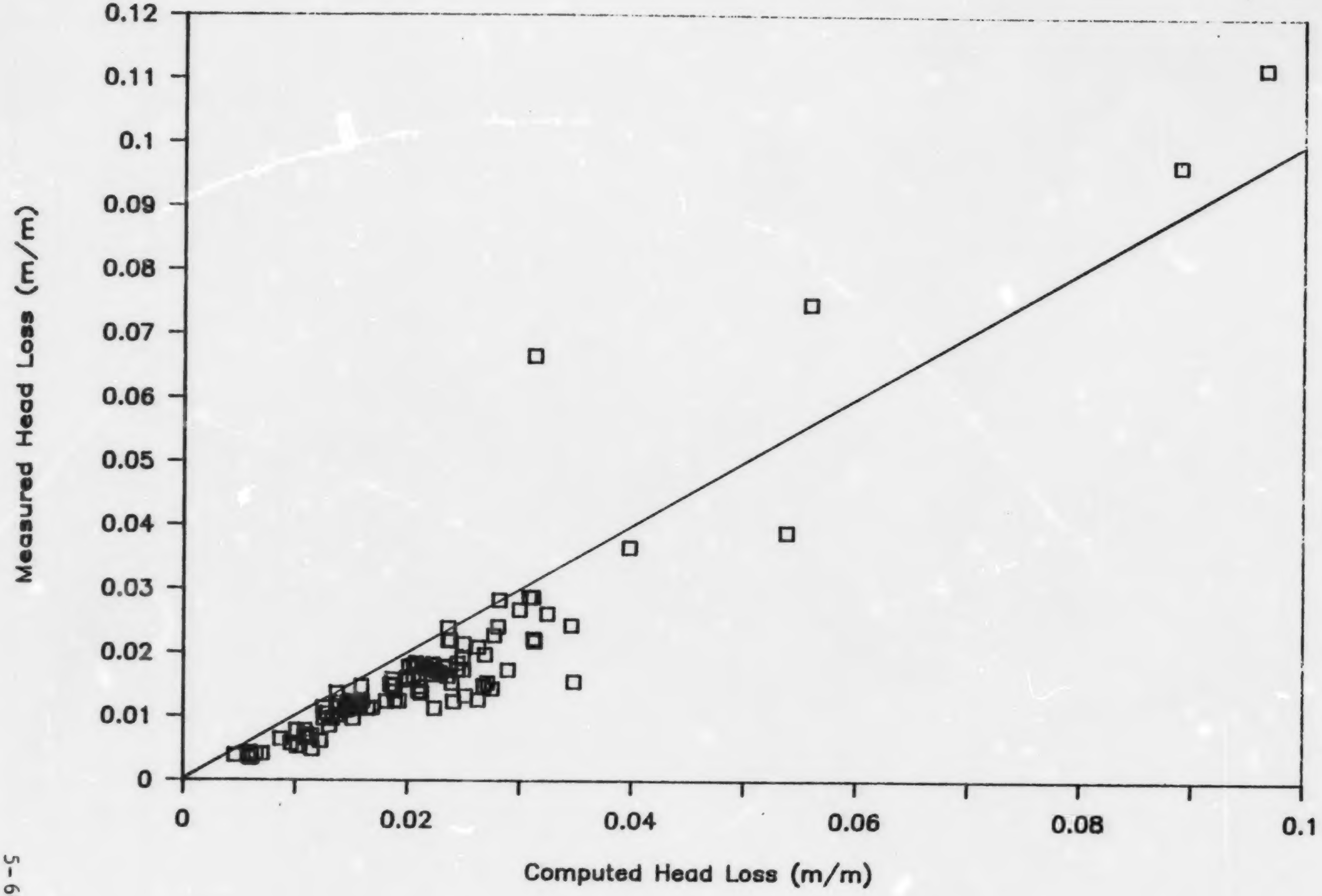


FIGURE 5-35

Pipeline Length vs Flowrate

Clear Water,1000 RPM/0.03 in

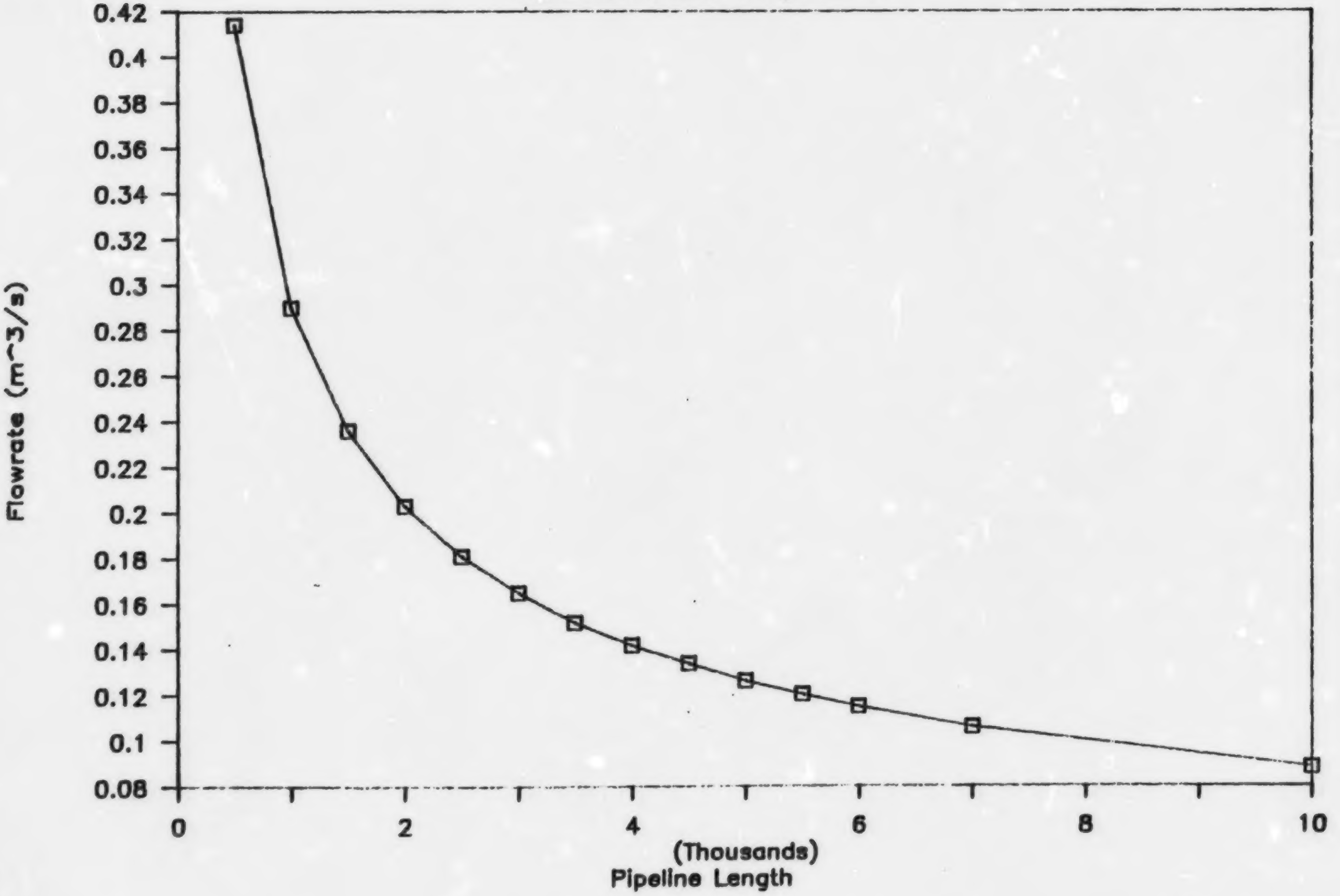


FIGURE 5-36A

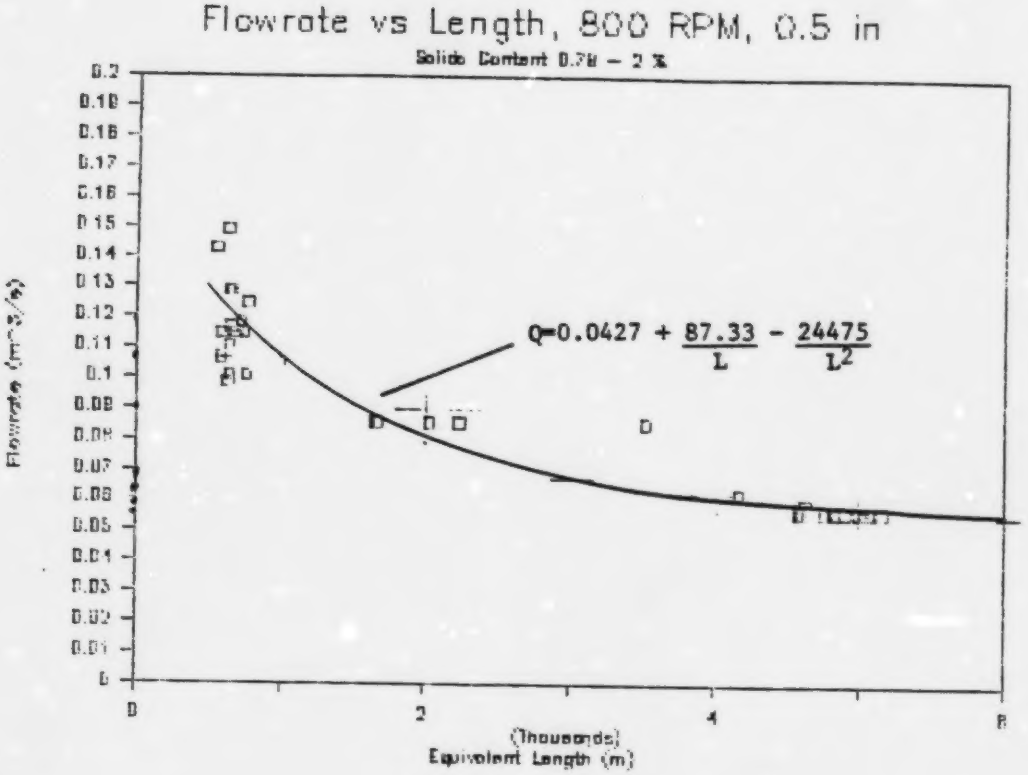


FIGURE 5-36B

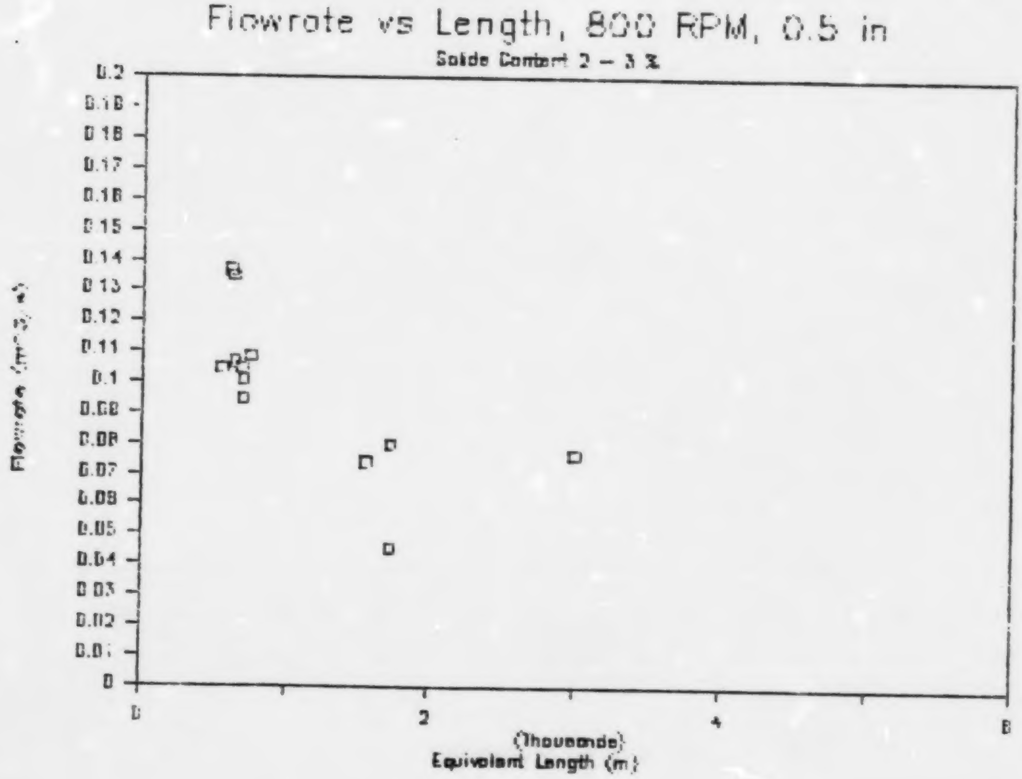


FIGURE 5-36C

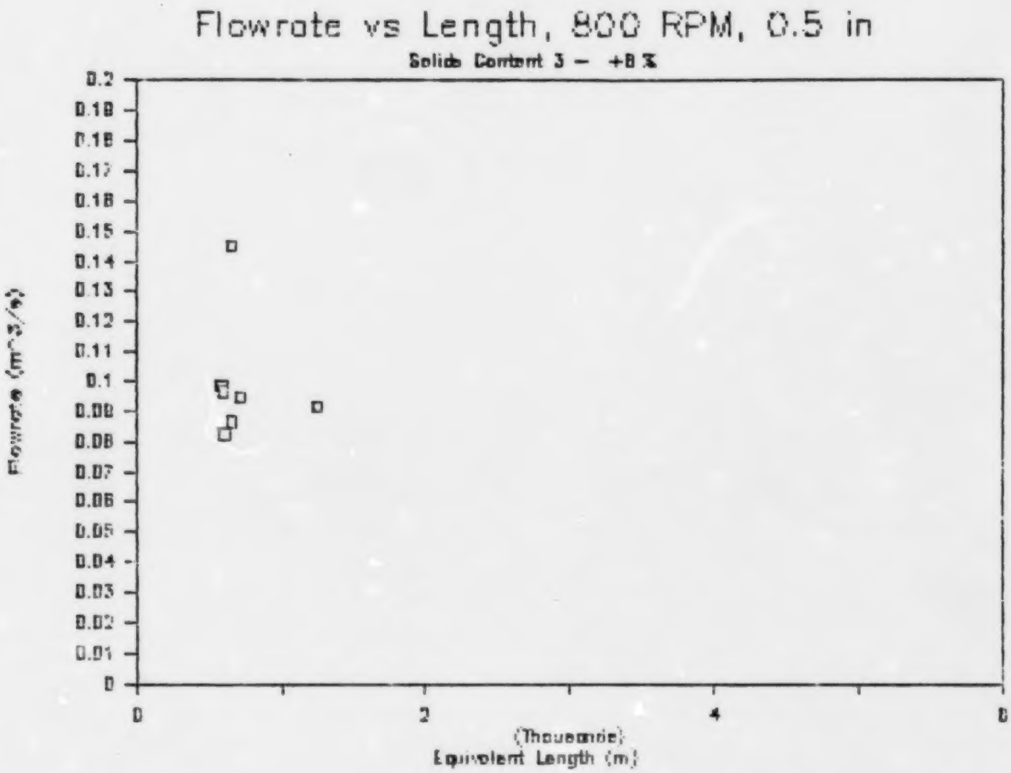

Flowrate vs Length, 800 RPM, 0.5 in
Solids Content 3 - +8 %
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Flowrate (m^3/s)
0
2
4
6
(Thousands)
Equivalent Length (m)

FIGURE 5-37A

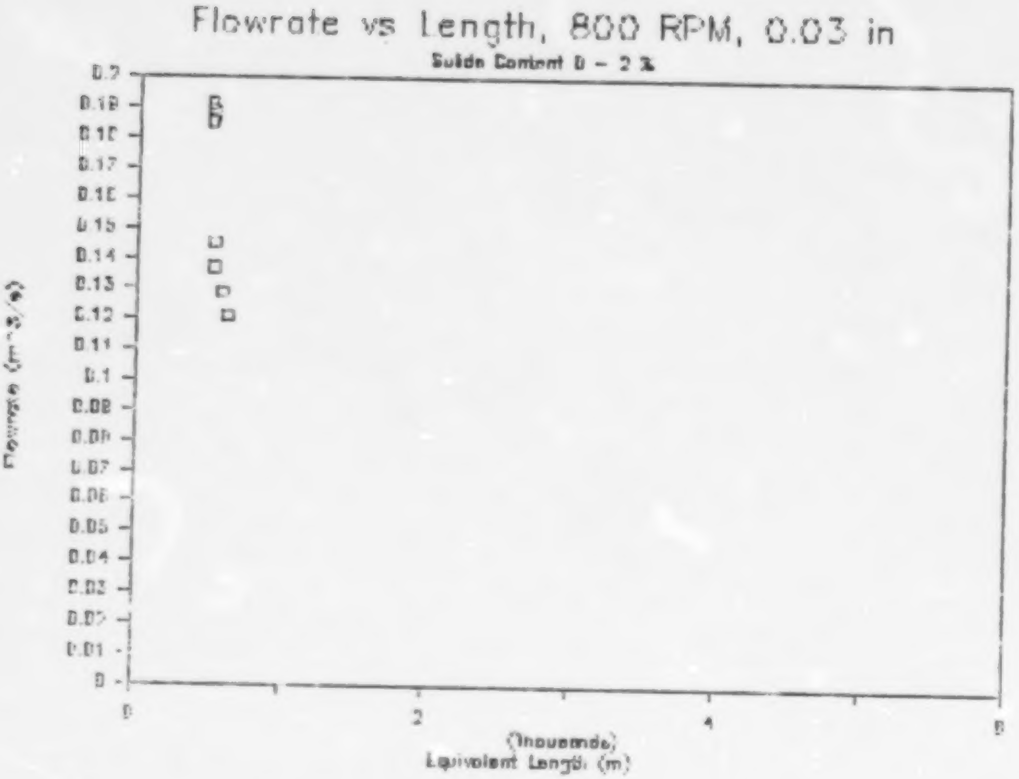


FIGURE 5-37B

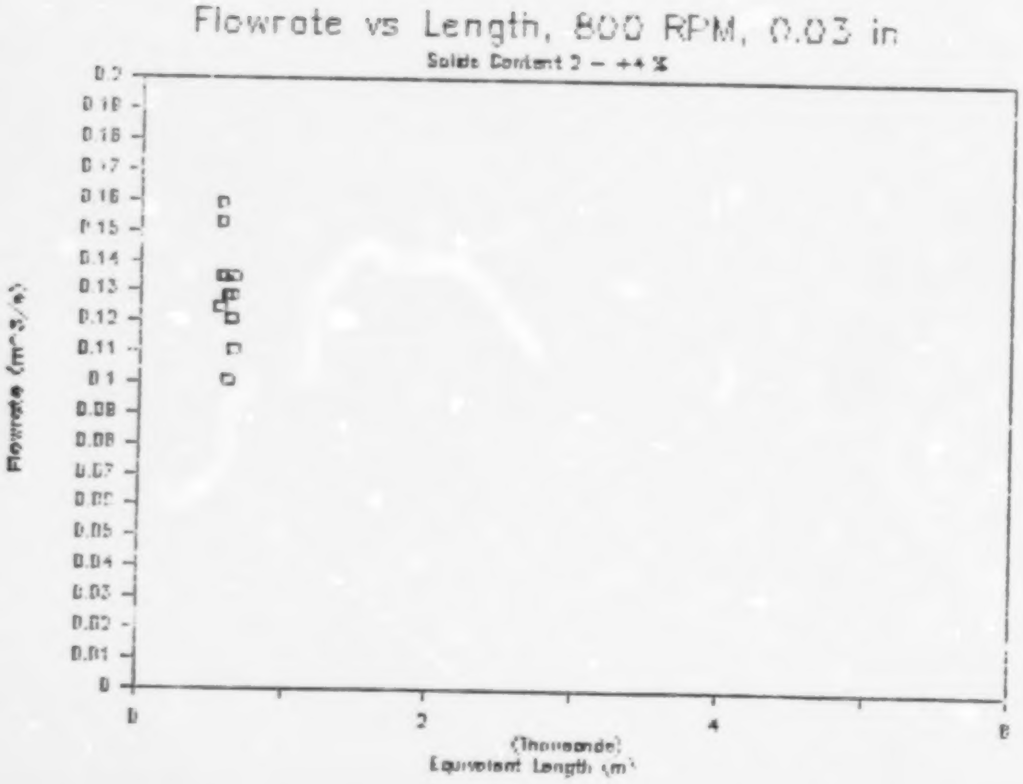


FIGURE 5-38A

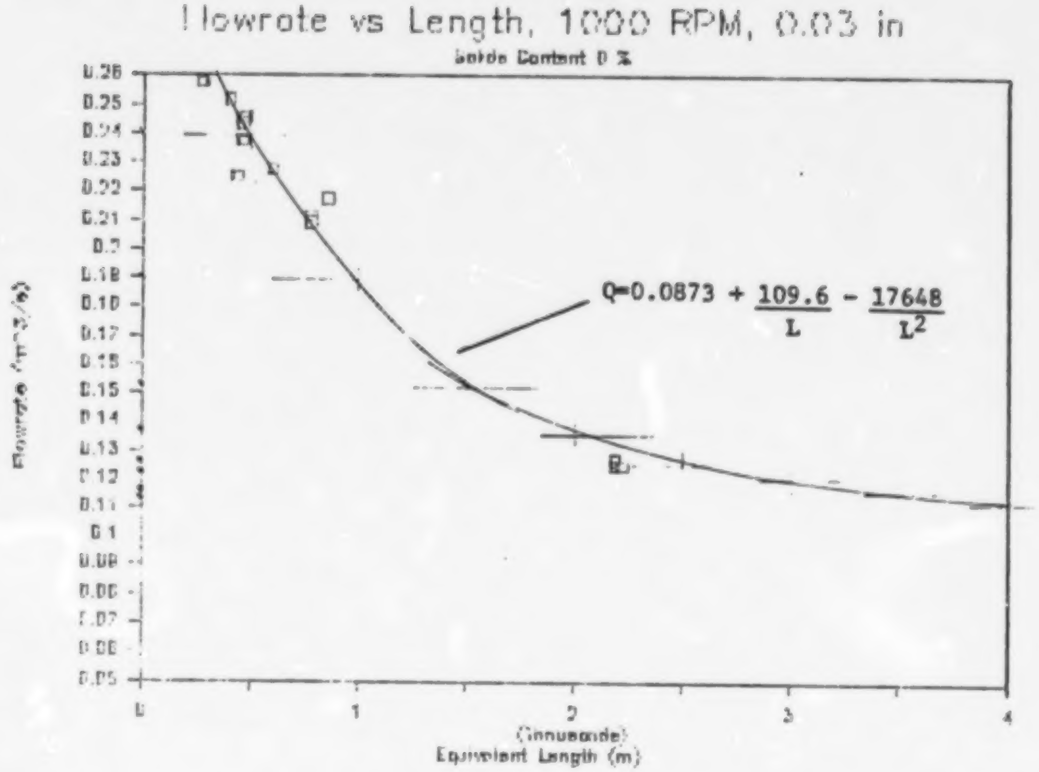


FIGURE 5-38B

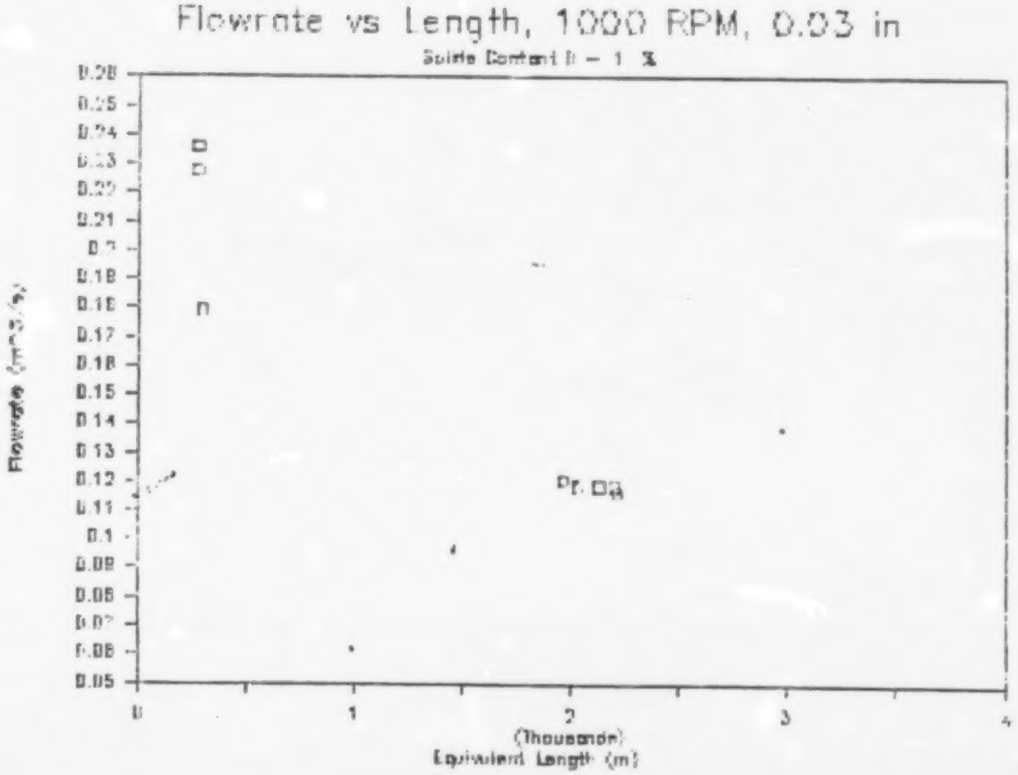


FIGURE 5-38C

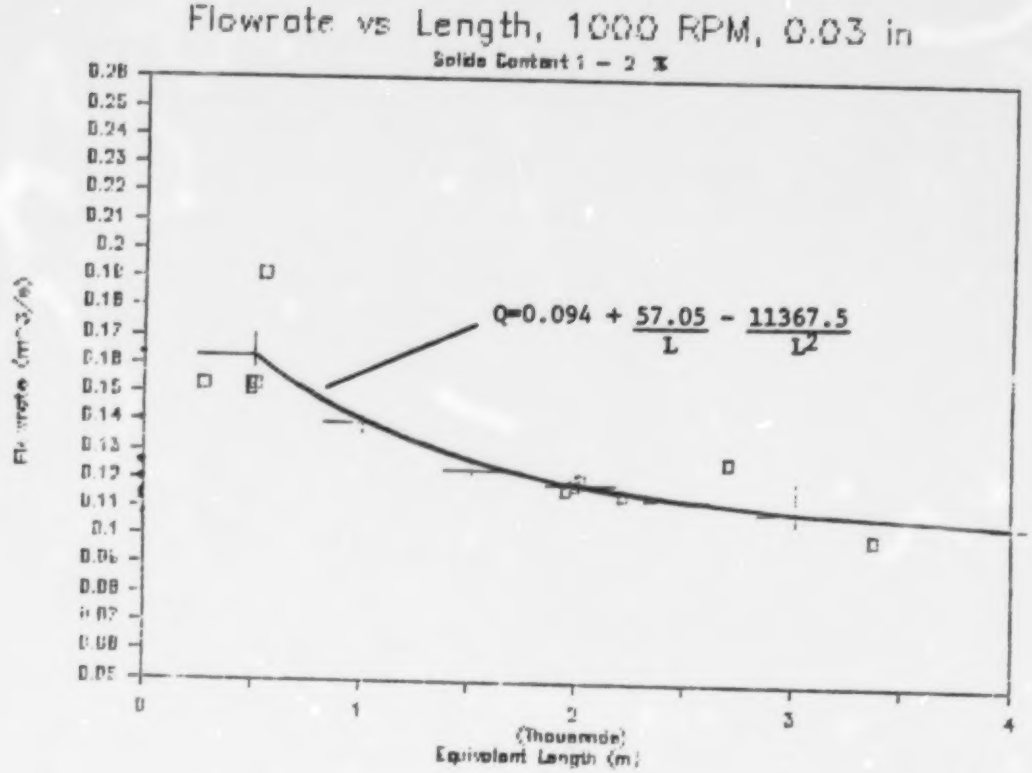


FIGURE 5-38D

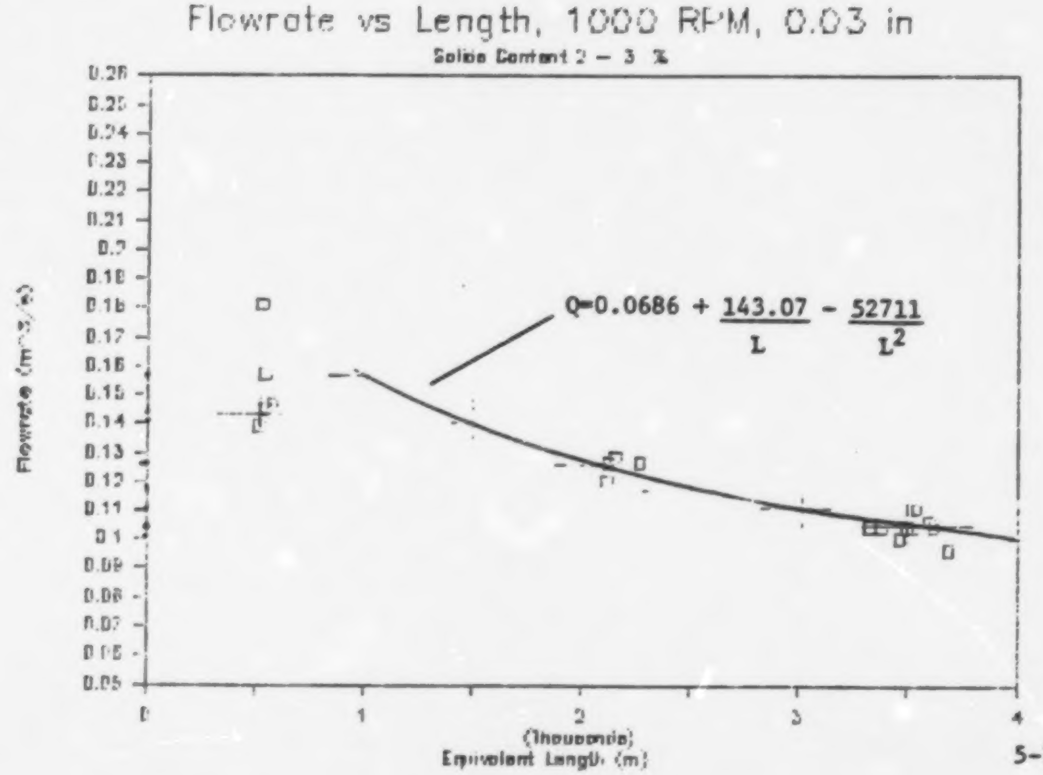


FIGURE 5-38E

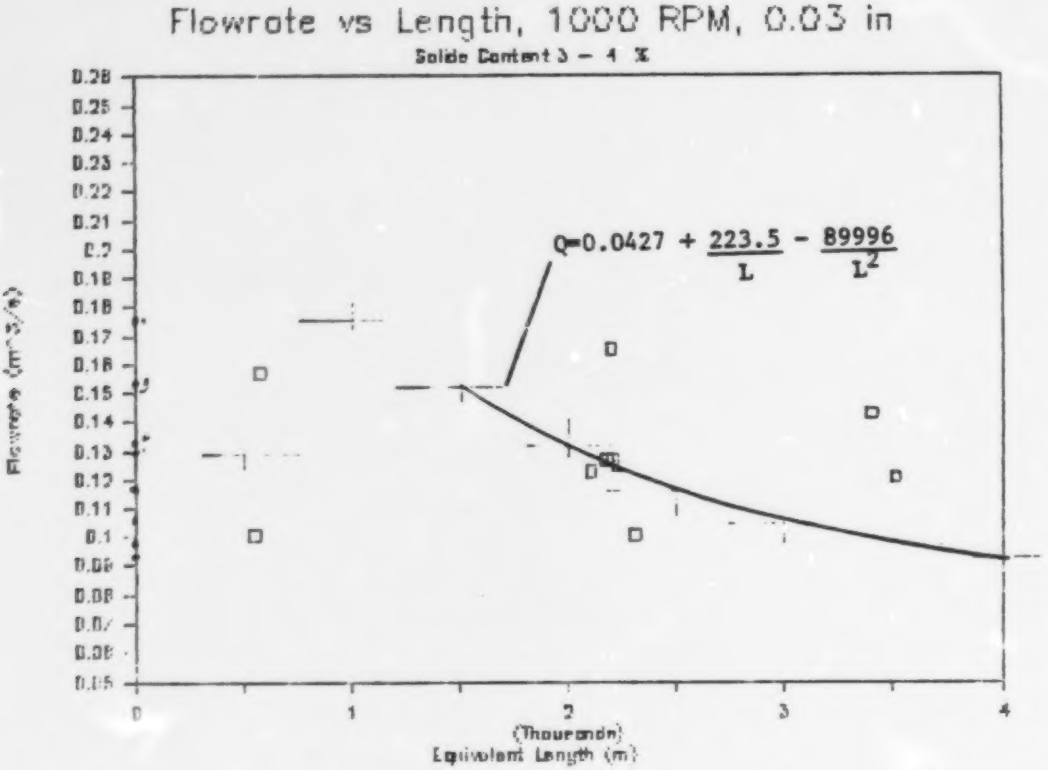

Flowrate vs Length, 1000 RPM, 0.03 in
Solids Content 3 - 4 %
$Q=0.0427+\frac{223.5}{L}-\frac{89996}{L^2}$
Flowrate (m^3/s)
0.26
0.25
0.24
0.23
0.22
0.21
0.2
0.19
0.18
0.17
0.16
0.15
0.14
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0
1
2
3
4
(Thousands)
Equivalent Length (m)

FIGURE 5-39A

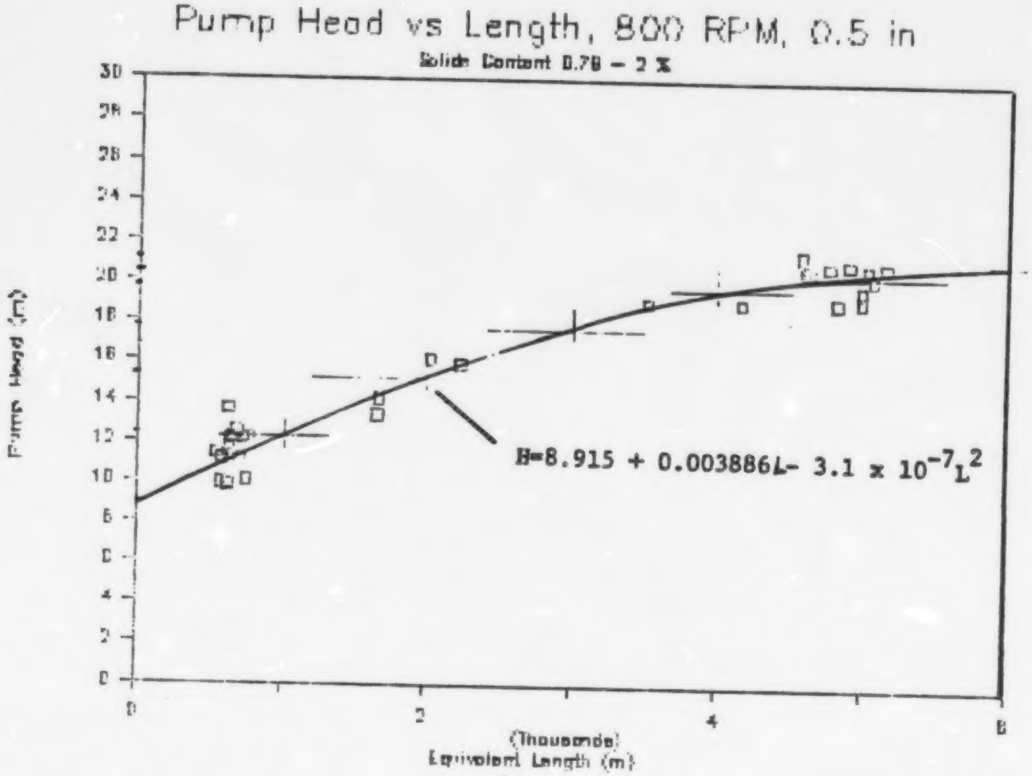


FIGURE 5-39B

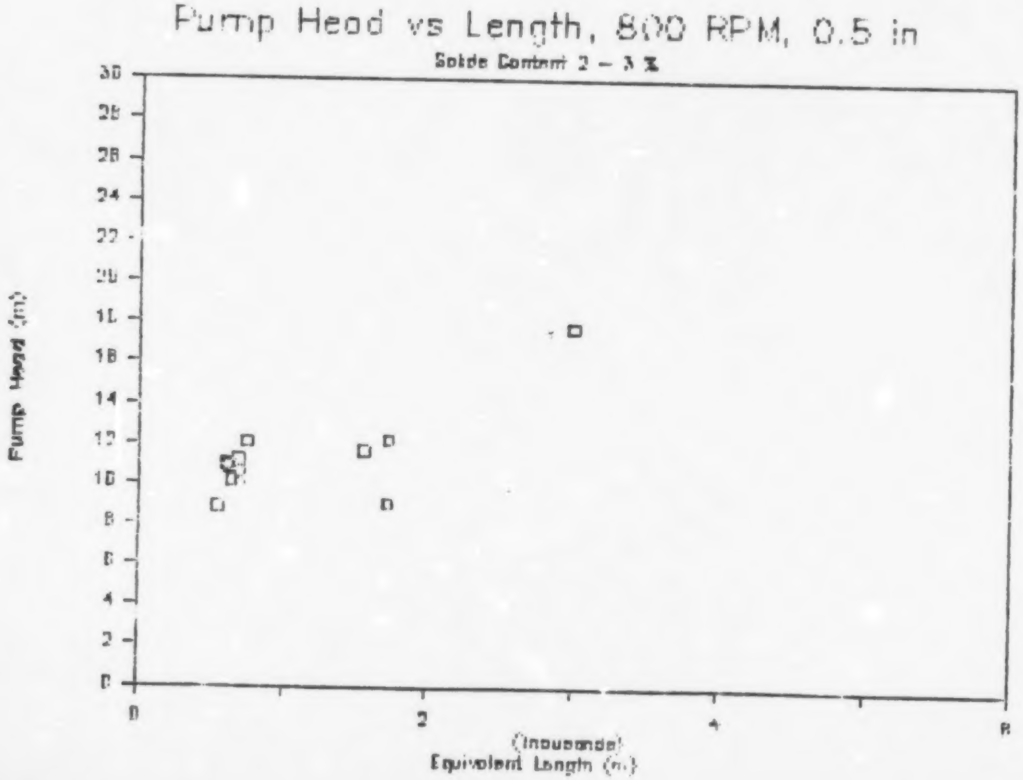


FIGURE 5-39C

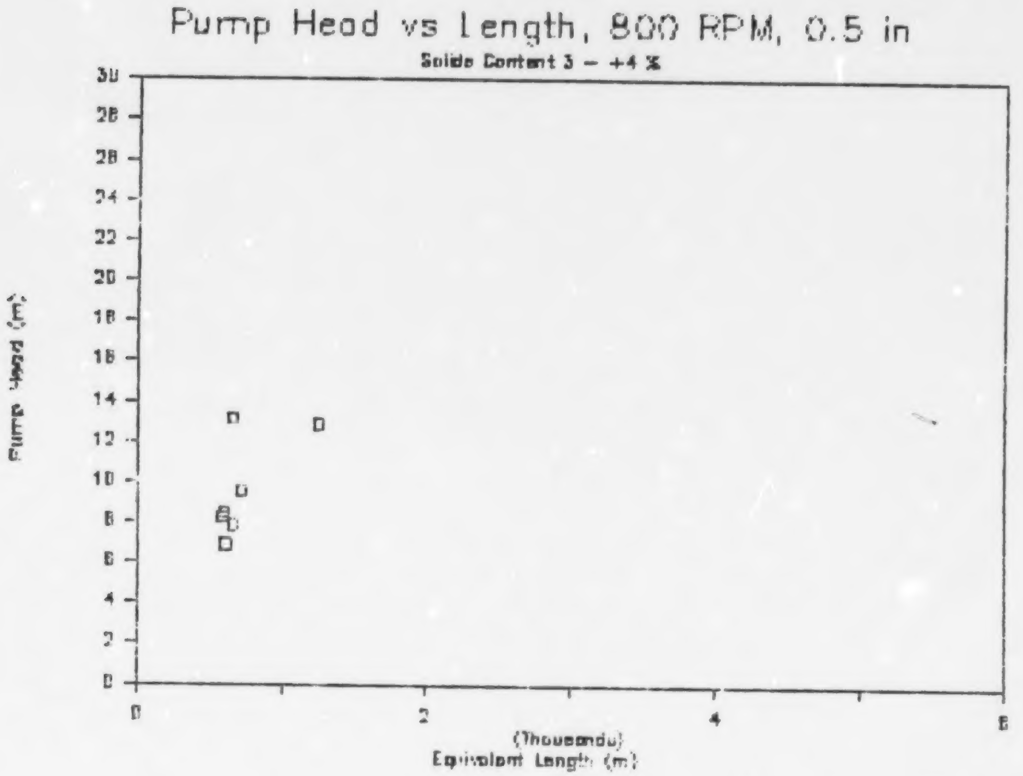

Pump Head vs Length, 800 RPM, 0.5 in
Solids Content 3 – +4 %
Pump Head (m)
30
28
26
24
22
20
18
16
14
12
10
8
6
4
2
0
0
2
4
6
(Thousands)
Equivalent Length (m)

FIGURE 5-40A

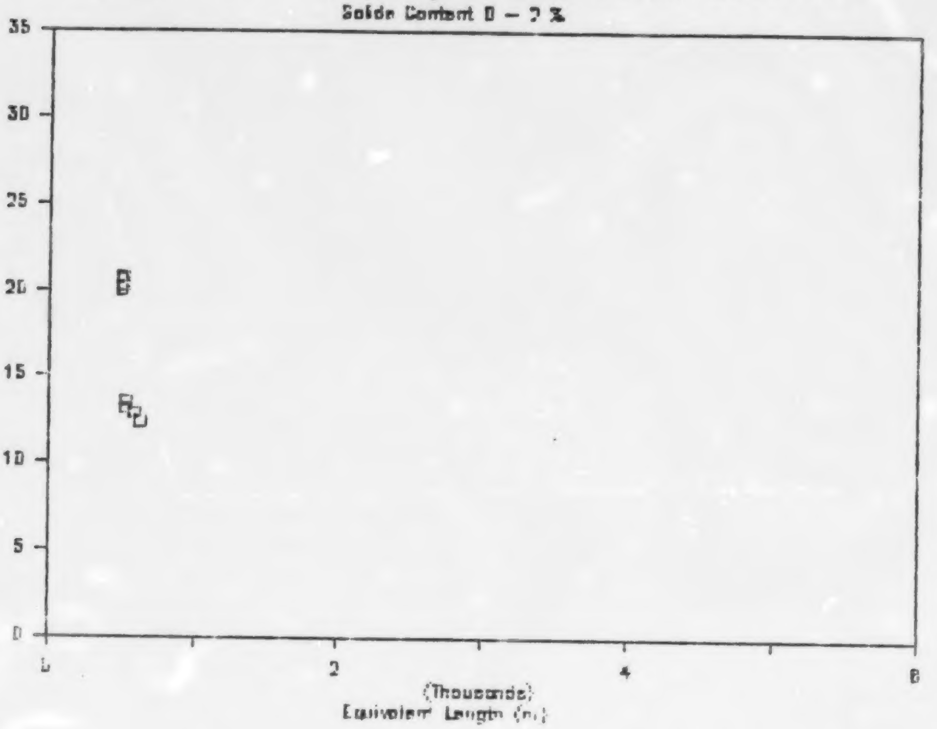


FIGURE 5-40B

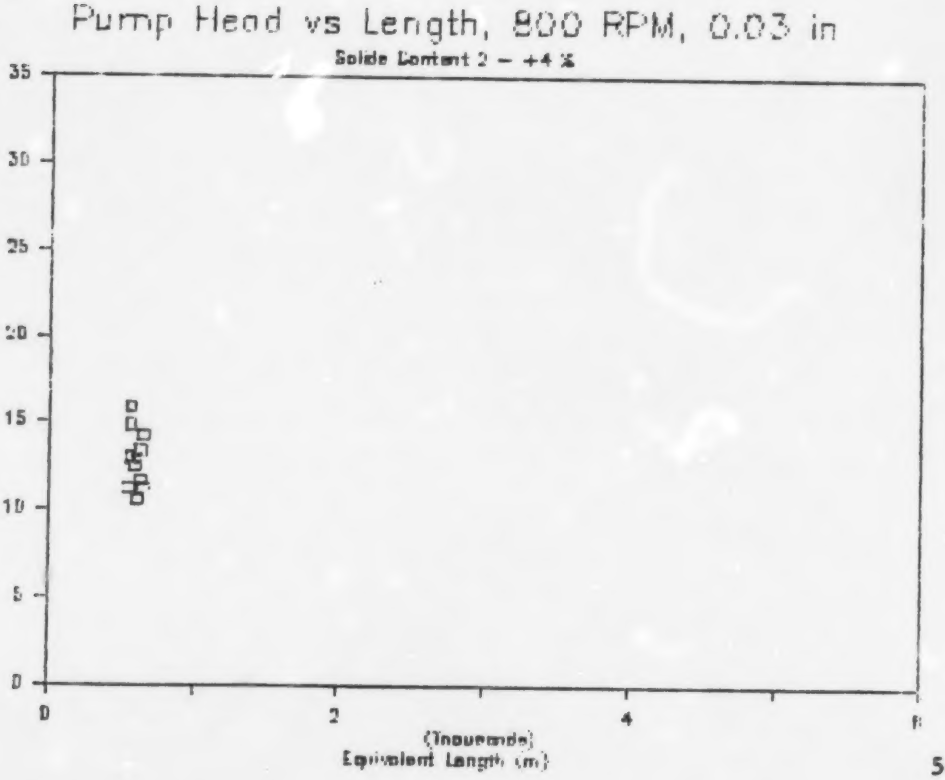


FIGURE 5-41A

Pump Head vs Length, 1000 RPM, 0.03 in

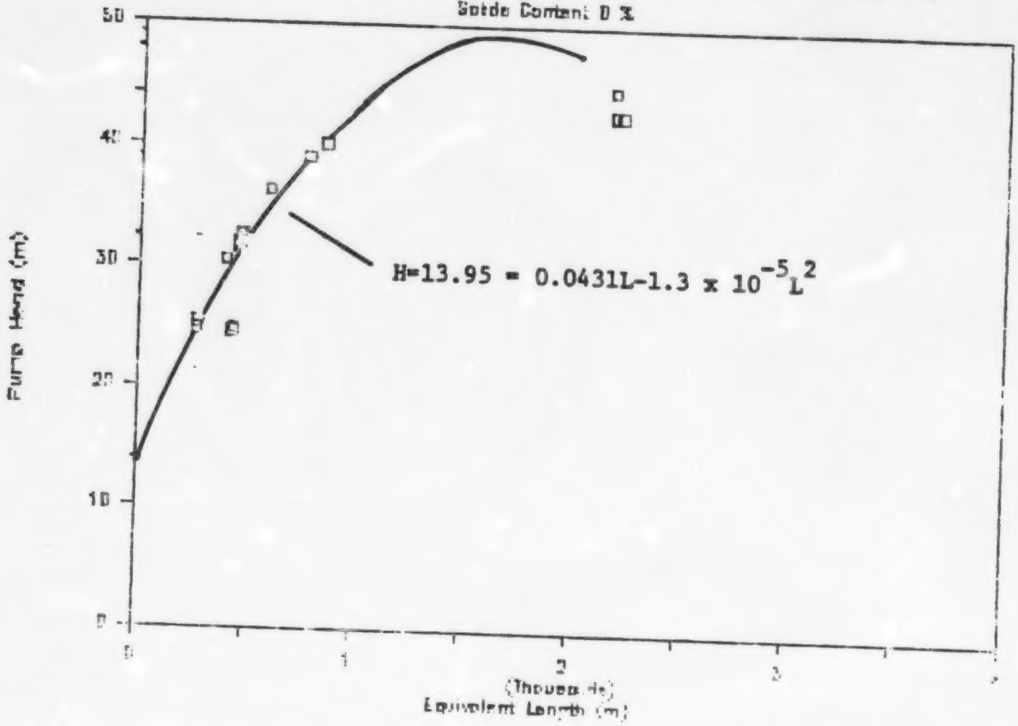
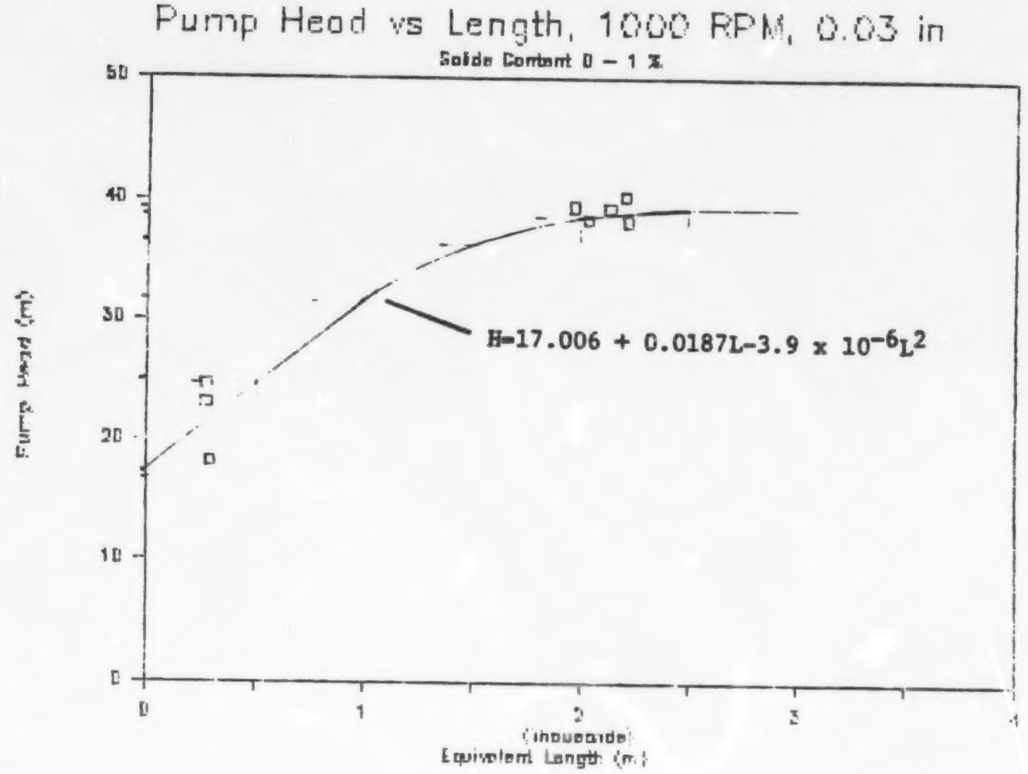


FIGURE 5-41B

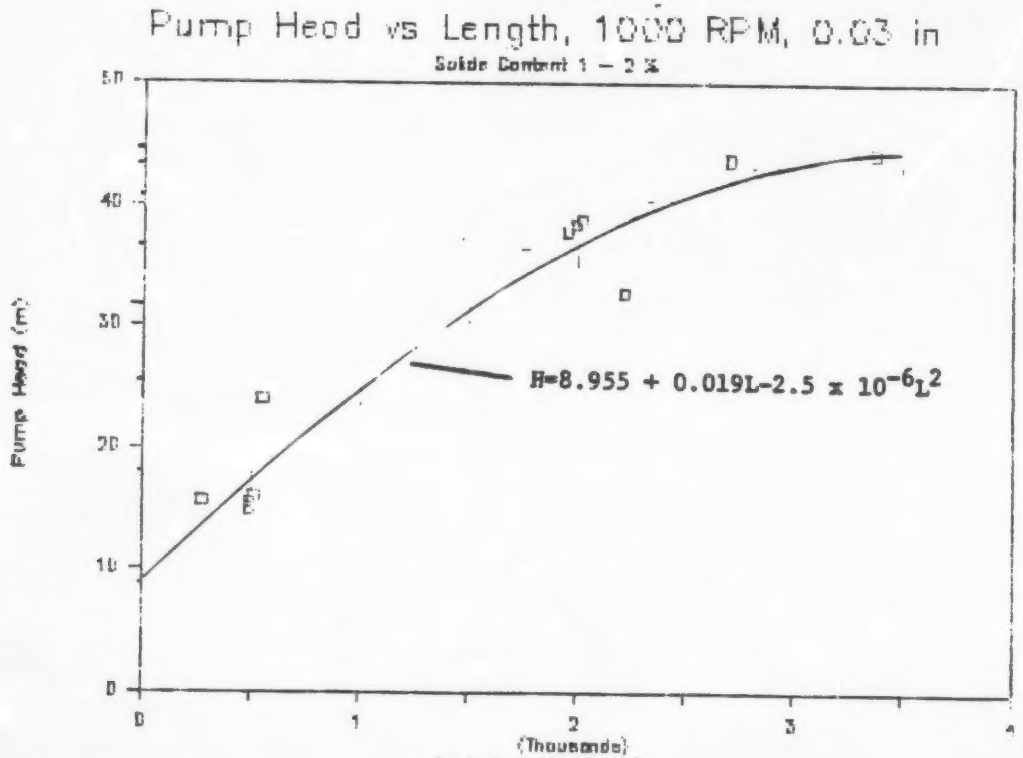


Pump Head vs Length, 1000 RPM, 0.03 in

Solids Content 0 – 1 %

$H = 17.006 + 0.0187L - 3.9 \times 10^{-6}L^2$

FIGURE 5-41C



Pump Head vs Length, 1000 RPM, 0.03 in

Solids Content 1 – 2 %

$H = 8.955 + 0.019L - 2.5 \times 10^{-6}L^2$

FIGURE 5-41D

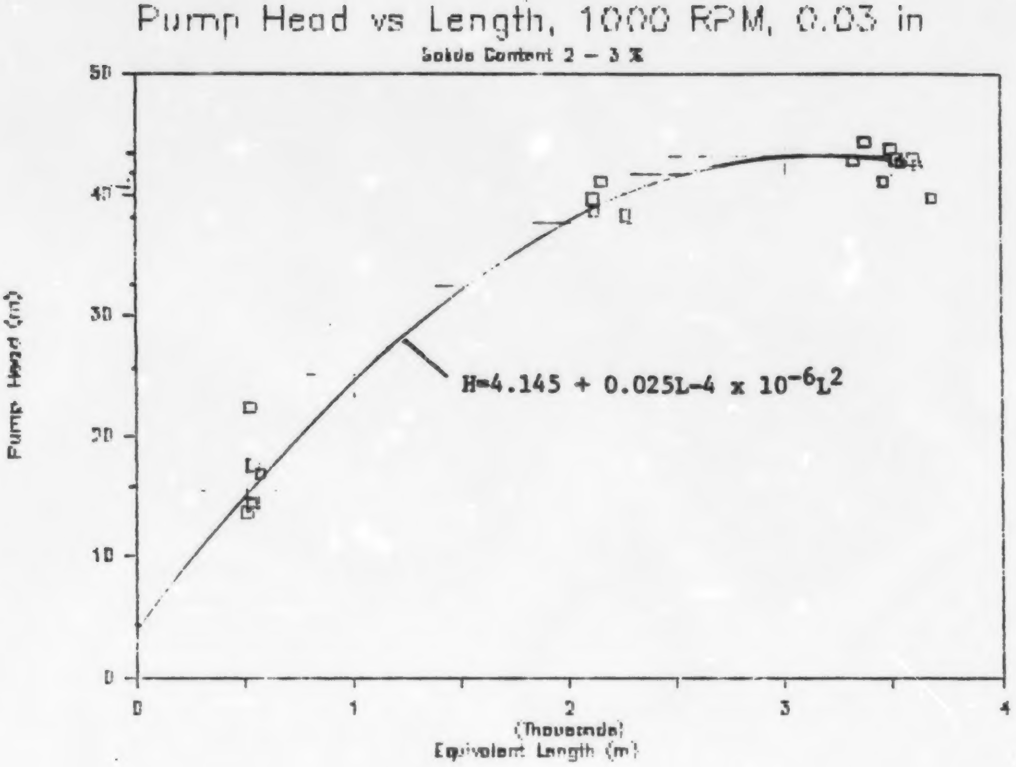
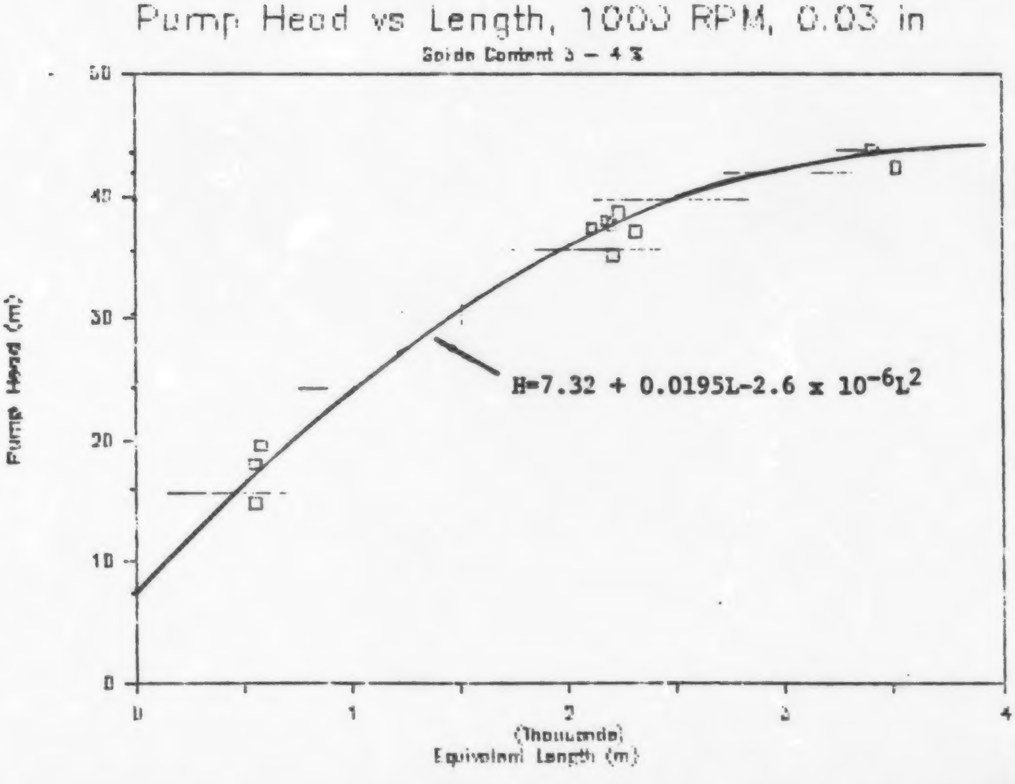


FIGURE 5-41E



PART 6

EVALUATION OF THE DEGREE OF MACERATION

PART 6 - EVALUATION OF THE DEGREE OF MACERATION

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6.1 INTRODUCTION

Samples were taken at the mining sump every hour for a period of approximately three hours each run and were mixed thoroughly together and later tested for particle size distribution, settlability, and dewaterability to determine how the parameters were affected by maceration of the peat which occurred during the mining operation. Similar samples were taken at the pipeline discharge end. A total of twenty peat slurry samples were tested for particle size distribution, settlability, and dewaterability. As well, an additional two raw peat samples were subjected to particle size analyses.

Results from the various tests are discussed in Section 6.5. The reader is also referred to the 1985 Monenco peat slurry pumping test (Reference 2) for further discussion on the assessment of degree of maceration.

6.2 PEAT SLURRY PARTICLE SIZE DISTRIBUTION TESTS

Test Procedure

Particle size distribution tests were performed using a wet sieving technique similar to that outlined in the NRC Peat Testing Manual (1979). Each slurry sample was washed through a series of sieves, and the collected peat solids dried (at 105 deg.C for a period of twenty-four hours minimum) and weighed for subsequent distribution calculations.

Test Results

Twenty particle size distributions for the samples from the various "runs" were carried out. The results are summarized in Table 6-1.

Sources of Error

For a discussion on sources of error, the reader is referred to previous work reported in the Ontario Geological Survey Open File Report 5572, "Laboratory Methods for Testing Peat, Ontario Peatland Inventory Project".

6.3 PEAT SLURRY SETTLABILITY TESTS

Test Procedure

Settling tests were performed on twenty peat slurry samples. Ten samples were taken at the sump, and ten at the discharge end of the pipeline.

Tests were performed according to a method recommended for sludge settling (Metcalf and Eddy Inc., 1979). Approximately 100 mls of sample were placed in a graduated cylinder and the change in the height of the interface with time was recorded.

To calculate the settling velocity of the peat slurry, the point where hindered settling began was noted from each settling curve. Subsidence (settling) velocity, V, from this portion of the settling curve was given by the formula:

$$V = (\text{Initial Height} - \text{Hindered Settling Height})/\text{Time}$$

Test Results

Twenty settlability tests were carried out, the results of which are summarized in Tables 6-2 and 6-3. The various settling curves are included in Appendix F.

6.4 PEAT SLURRY DEWATERABILITY TESTS

Filtration characteristics of the slurries were obtained in the laboratory by use of the Buchner Funnel Test which permits the determination of specific resistance.

A well mixed slurry sample was transferred to the funnel and a vacuum was applied. Filtrate volume, after specific time intervals, was recorded until vacuum broke. Using initial and final solids concentration in the feed slurry and cake, the specific resistance was calculated.

$$\frac{t}{V} = \frac{(urc)}{(2PA^2)} V + \frac{urm}{(PA)}$$

Where V = volume of filtrate,
t = time,
P = pressure,
A = filtration area,
u = filtrate viscosity,
r = specific resistance, and
c = weight of solids per unit volume of filtrate.

From the above equation, a linear relationship results from a plot of t/v versus V. The specific resistance can be computed from the slope of this plot:

$$r = \frac{2bPA}{uc},$$

where b is the slope of the plot t/v versus V. The weight of solids per unit volume of filtrate, c, is computed from the relationship:

$$c = 1/[ci/(100 - ci) - cf/(100 - cf)]$$

where ci = initial moisture content of slurry, and

cf = final moisture content of slurry.

Test Results

Twenty dewaterability tests were carried out, the results of which are summarized in Table 6-4. Graphs are found in Appendix F.

For a sample calculation, consider test 7 at discharge:

Initial moisture content = 97.60%

Final moisture content = 80.19%

"c", which is the weight of solids per unit volume of filtrate is:

$$c = \frac{1}{(ci/(100 - ci) - cf/(100 - cf))}$$

$$c = \frac{1}{97.60/(100 - 97.60) - 80.19/(100 - 80.19)}$$

$$= 0.027.$$

Also, P = pressure = 27.3" Hg = 961 g/cm,

A = filtration area = 44.18 cm^2

u = filtrate kinematic viscosity = 0.01 cm^2/s

b = slope = 0.000028 s/cm^6 (found from graph located in Appendix F).

Therefore,

$$r = \frac{(2)\ (0.000028)\ (961)\ (44.18)}{(0.01)\ (0.027)}$$

$$r = 3.892 \times 10^5\ s^2/g.$$

6.5 DISCUSSION

From the analysis of the in-situ peat ("C" and "I"), it appears that hydromonitoring did contribute significantly to the maceration of the peat type tested. Plots of the particle size distribution for samples of raw peat, sump material, and pipeline discharge (not included) at the coarser sieve sizes (2 mm, 1 mm and 0.6 mm) show this. The cumulative weight distribution curves tended to converge at the 0.149 mm and particularly the 0.063 mm sieve sizes, i.e. these sieves retained roughly the same amount of peat for all three types of samples (raw peat, sump and discharge) indicating that very little maceration (comminution) occurred at this size range.

It appears that the peat in the sump (sump samples) became finer throughout the tests. It is not understood whether this was due to changes in the pump rotational speed and the "egg-beater" effect of the external propeller, or possibly a change in sump configuration and longer retention time of peat particles as the active working area increased.

Differences in particle size distribution between sump and discharge samples generally show that greatest particle size degradation (reduction), due to the action of the pump and pipeline system, occurred at pump settings of 800 rpm and 0.5 inch clearance between the impeller and wear plate. The test conducted at 800 rpm and 0.5 inch clearance generally had lower flow rates, but the 0.5 inch clearance caused considerable re-circulation of slurry within the pump. The least amount of particle size degradation appears to occur at 800 rpm pump speed and 0.03 inch clearance setting where very little recirculation occurs within the pump, pump efficiency is higher and the power requirement was only 14% higher than at the 800 rpm/0.5 inch settings. The amount of particle size reduction at the 1000 rpm/0.03 inch settings appears to be somewhere between the other two tests, possibly because of the higher rotational speed of the external propeller and impeller and the low recirculation within the pump at 0.03 inch clearance.

Because of surging within the sump during the tests, settling out of fine particles during shut-down periods, uneven raking of the hydromonitor jets on the mining face and in the sump area, etc. it is considered difficult to draw more than general conclusions on particle size distribution with the limited number of samples available.

Specific resistance, which is a measure of dewaterability, decreases with increasing solids content with increasing solids content as shown in Figure 6-1. This is expected, and, since slurry viscosity increases exponentially with solids content, dewaterability decreases exponentially with slurry viscosity.

From Table 6-1 and Figure 6-2, it can be seen that the settlability (subsidence velocities) decreases exponentially with increasing solids content.

Both settlability and dewaterability are peat slurry properties which have a significant effect on wet peat mining operating conditions. Both settlability and dewaterability decreased with an increase in slurry solids content. Settlability decreases rapidly between 1.5% and 3% total solids. Dewaterability also decreases with increasing solids content, through this relationship appears to follow a less dramatic curve than does settlability, which is exponential.

TABLE 6-1

Particle Size Distribution Test Results
(% Distribution by Weight)

Particle Size	In-Situ Peat Samples		PEAT SLURRY SAMPLES																			
			Run No. 1 Sump	Run No. 1 Disch.	Run No. 2 Sump	Run No. 2 Disch.	Run No. 3 Sump	Run No. 3 Disch.	Run No. 4 Sump	Run No. 4 Disch.	Run No. 5 Sump	Run No. 5 Disch.	Run No. 6 Sump	Run No. 6 Disch.	Run No. 7 Sump	Run No. 7 Disch.	Run No. 8 Sump	Run No. 8 Disch.	SP-1 Sump	SP-1 Disch.	SP-2 Sump	SP-2 Disch.
			TEST NUMBER																			
	"C"	"I"	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2mm	38.8	26.1	13.3	11.8	15.3	7.9	12.4	5.5	8.1	6.2	13.9	6.8	4.7	4.0	4.5	4.2	6.9	4.5	11.4	8.1	9.0	7.0
2mm & 1mm	7.5	4.8	9.4	5.4	14.4	6.3	9.2	3.6	7.3	4.9	3.3	5.6	4.3	2.5	3.5	3.3	4.2	4.5	8.4	7.0	6.3	5.7
1mm & 0.6mm	5.1	3.2	6.7	0.7	11.7	3.9	7.0	4.4	5.7	4.3	5.6	6.0	2.8	1.4	3.5	2.1	4.2	2.3	6.4	5.4	5.5	4.1
0.6mm & 0.149mm	17.0	4.4	17.8	19.0	19.8	29.9	20.0	20.7	26.0	32.1	21.7	19.2	16.6	19.4	19.8	22.9	27.8	27.3	15.3	20.2	15.3	18.5
0.149mm & 0.063mm	6.9	20.3	18.3	21.8	22.5	35.4	25.9	22.5	30.1	29.0	25.5	25.2	29.9	25.9	32.2	32.5	29.2	25.0	15.8	16.3	19.2	22.8
0.063mm	24.7	41.2	34.5	41.3	16.3	16.6	25.5	43.3	22.8	23.5	25.0	37.2	41.7	46.8	36.5	35.0	27.7	36.4	42.7	43.0	44.7	41.9

TABLE 6-2

Peat Slurry Settlability Test Results

Time (min)	1 at Sump	2 at Sump	3 at Sump	4 at Sump	5 at Sump	6 at Sump	7 at Sump	8 at Sump	1 at Discharge	2 at Discharge	3 at Discharge	4 at Discharge	5 at Discharge	6 at Discharge	7 at Discharge	8 at Discharge	SP-1 Sump	SP-2 Sump	SP-1 Discharge	SP-2 Discharge
	Interface Height (cm) Test Number																			
0	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
5	13.5	8.5	16.5	13.5	17.5	18.5	19.5	7.5	16.5	9.5	19.0	14.0	18.6	19.5	19.5	9.1	13.4	16.5	16.5	19.0
10	9.9	7.5	13.0	10.5	13.5	16.0	18.5	6.6	14.0	6.6	18.5	13.0	18.0	19.0	18.5	6.5	9.7	13.1	14.2	18.4
15	9.2	6.8	11.2	9.5	12.8	14.7	18.2	6.3	12.8	6.2	18.0	11.8	18.0	19.0	17.5	6.0	9.0	11.3	12.9	18.0
30	8.3	6.1	9.7	8.6	10.6	12.6	15.9	5.8	10.0	5.9	15.6	9.5	18.0	18.5	16.7	5.5	8.1	9.7	10.1	15.5
60	7.6	5.7	8.9	8.1	9.5	10.7	13.1	5.7	8.8	5.2	13.0	8.5	17.4	14.6	14.2	5.0	7.5	8.8	8.9	13.1
120	7.4	5.6	8.6	7.9	9.1	9.9	11.2	5.6	8.5	5.1	11.6	8.1	15.1	12.0	12.2	4.6	7.2	8.7	8.6	11.5
180	7.3	5.6	8.5	7.7	9.0	9.8	10.7	5.5	8.3	5.1	11.5	7.9	13.5	10.5	11.0	4.5	7.2	8.5	8.5	11.4
240	7.3	5.6	8.4	7.7	9.0	9.6	10.6	5.5	8.3	4.9	11.3	7.8	12.5	10.1	9.7	4.4	7.2	8.4	8.4	11.3
300	7.2	5.6	8.4	7.7	9.0	9.5	10.4	5.5	8.2	4.9	11.1	7.7	11.6	9.7	9.5	4.4	7.1	8.4	8.3	11.1
1440	7.1	5.6	8.4	7.7	8.9	9.3	10.2	5.5	8.1	4.9	10.9	7.7	11.0	9.5	9.0	4.4	7.1	8.4	8.2	10.9

TABLE 6-3

Subsidence Velocities for Peat Slurries

Test Number	Subsidence Velocity (cm/hour)
No. 1 at sump	60.6
No. 2 at sump	52.8
No. 3 at sump	35.2
No. 4 at sump	57.0
No. 5 at sump	28.8
No. 6 at sump	14.8
No. 7 at sump	6.9
No. 8 at sump	80.4
"Special" No. 1 at sump	58.5
"Special" No. 2 at sump	37.5
No. 1 at discharge	28.8
No. 2 at discharge	55.2
No. 3 at discharge	8.8
No. 4 at discharge	32.8
No. 5 at discharge	2.5
No. 6 at discharge	5.4
No. 7 at discharge	5.8
No. 8 at discharge	78.2
"Special" No. 1 at discharge	27.8
"Special" No. 2 at discharge	13.5

TABLE 6-4

Specific Resistance of Peat Slurry to Dewatering

Test Number	Initial Moisture Content (%)	Final Moisture Content (%)	Filtrate Concentration c	Pressure (inch Hg)	Slope (sec/cm^6)	Specific Resistance (sec^2/gram)
Run No. 1 at Sump	98.20	63.10	0.018	25	4.6×10^{-5}	8.799×10^{5}
Run No. 2 at Sump	98.89	80.90	0.011	27.3	3.4×10^{-5}	1.159×10^{6}
Run No. 3 at Sump	98.15	83.52	0.020	27.3	6.1×10^{-5}	1.144×10^{6}
Run No. 4 at Sump	98.77	82.13	0.013	27.3	4.1×10^{-5}	1.183×10^{6}
Run No. 5 at Sump	98.20	82.84	0.020	27.3	4.7×10^{-5}	8.913×10^{5}
Run No. 6 at Sump	97.89	79.76	0.023	27.3	3.0×10^{-5}	4.822×10^{5}
Run No. 7 at Sump	97.98	80.77	0.022	27.3	2.2×10^{-5}	3.785×10^{5}
Run No. 8 at Sump	99.28	80.71	0.0074	27.3	2.6×10^{-5}	1.318×10^{6}
Special No. 1 at Sump	97.82	80.79	0.025	27.3	4.5×10^{-5}	6.753×10^{5}
Special No. 2 at Sump	97.45	80.21	0.029	27.3	5.9×10^{-5}	7.632×10^{5}
Run No. 1 at Discharge	97.66	81.09	0.026	27.3	5.3×10^{-5}	7.487×10^{5}
Run No. 2 at Discharge	98.73	77.10	0.013	27.3	2.9×10^{-5}	8.138×10^{5}
Run No. 3 at Discharge	97.25	80.07	0.031	27.3	8.3×10^{-5}	9.799×10^{5}
Run No. 4 at Discharge	98.38	82.14	0.017	27.3	4.4×10^{-5}	9.299×10^{5}
Run No. 5 at Discharge	97.50	82.43	0.029	27.3	3.9×10^{-5}	5.041×10^{5}
Run No. 6 at Discharge	97.22	79.98	0.032	27.3	3.4×10^{-5}	4.002×10^{5}
Run No. 7 at Discharge	97.60	80.19	0.027	27.3	2.8×10^{-5}	3.892×10^{5}
Run No. 8 at Discharge	99.12	79.07	0.0091	27.3	2.3×10^{-5}	9.529×10^{5}
SP-1 at Discharge	97.42	80.19	0.030	27.3	5.1×10^{-5}	6.377×10^{5}
SP-2 at Discharge	97.02	80.05	0.035	27.3	8.1×10^{-5}	8.682×10^{5}

NO. 341-M DIETZGEN GRAPH PAPER
MILLIMETER

DIETZGEN CORPORATION
MADE IN U.S.A.

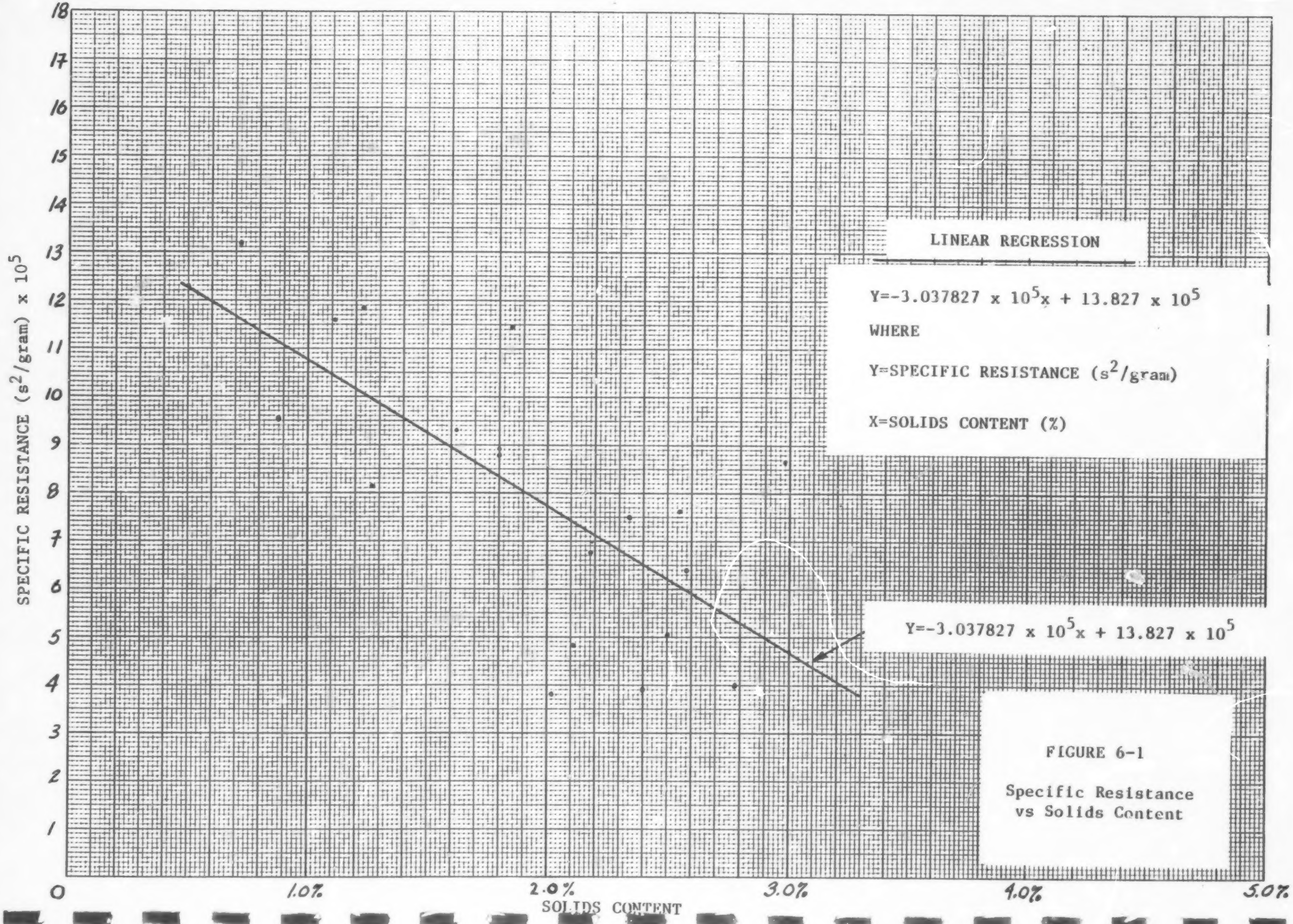
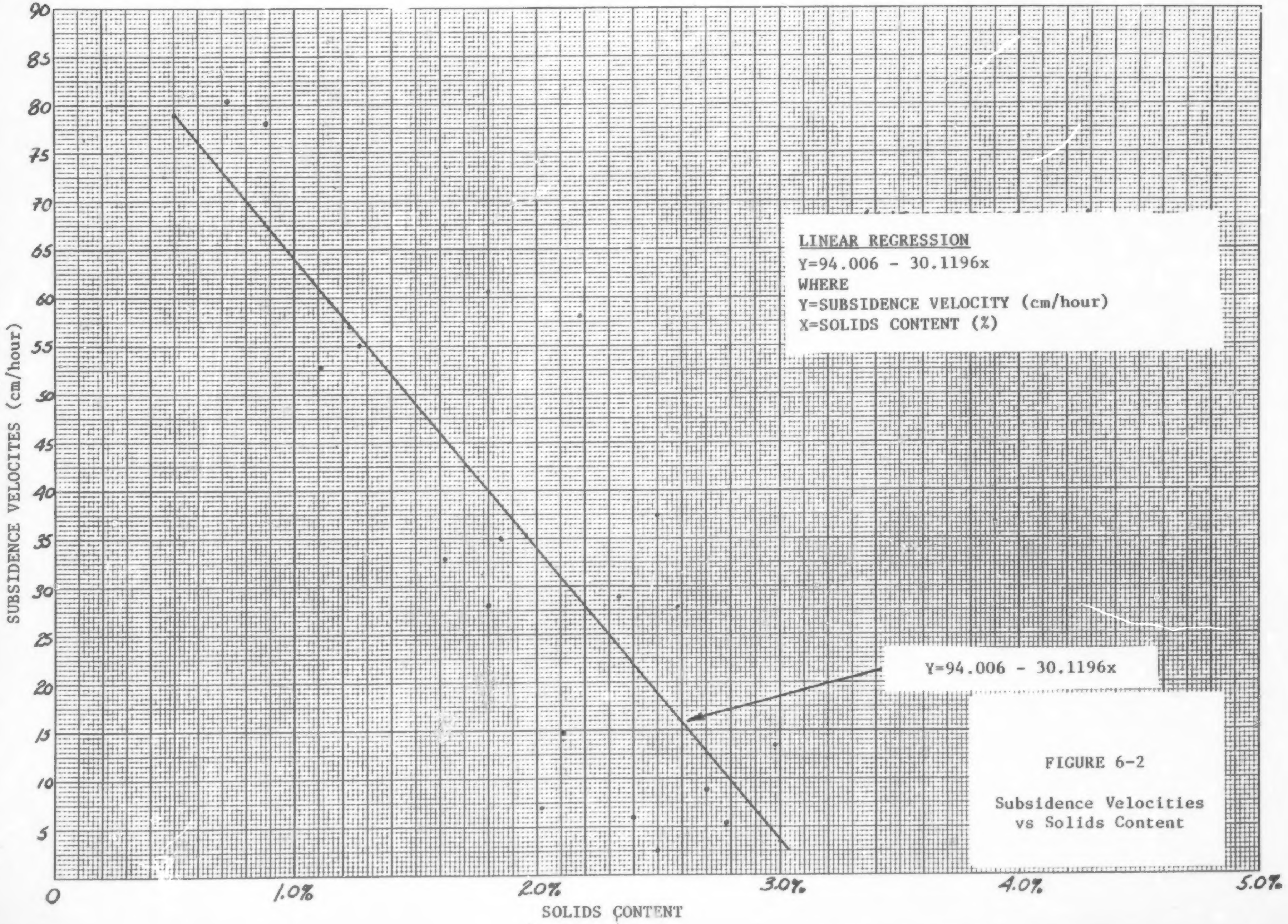


FIGURE 6-1

Specific Resistance vs Solids Content

MILLIMETER
MADE IN U.S.A.



LINEAR REGRESSION
Y=94.006 - 30.1196x
WHERE
Y=SUBSIDENCE VELOCITY (cm/hour)
X=SOLIDS CONTENT (%)

FIGURE 6-2

Subsidence Velocities
vs Solids Content

APPENDIX A

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

TEST No.1, RUN No.1
DATE: JULY 26, & 28 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

PEAT SLURRY PUMP | PEAT SLURRY PIPELINE

TIME	RPM	DEPTH OF SUBMISSION (ft.)	(m)	DISCHARGE PRESSURE (ft.)	(m)	FLOW RATE GPM	m^3PM	POWER DEMAND HP.	Kw	ENERGY DEMAND Kwh	BRAKE HORSEPOWER HP	Kw	HYDRAULIC HORSEPOWER HP	Kw	Eff. %	TOTAL FLOW GAL	m^3	VELOCITY ft./s	m/s	TEMP °C	SOLIDS CONTENT %	ASH CONTENT %	VISCOSITY cps	SPECIFIC GRAVITY •	KINEMATIC VISCOSITY ft²/s	m²/s	REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
15	755	2.625	0.80	41.9	12.76	1445.	5.47	102.39	76.35	19.09	93.88	70.01	15.30	11.41	16.30	21675.	82.05	4.53	1.38	17.9	6.32	39.58	170.0	1.030	0.0017765	0.00016505	2425.	2576.
45	770	2.625	0.80	45.1	13.74	1361.	5.15	99.91	74.50	18.63	91.62	68.32	15.52	11.57	16.94	20415.	77.25	4.25	1.30	19.6	1.76	12.07	18.5	1.004	0.0001984	0.00001843	20460.	21734.
60	766	2.625	0.80	42.8	13.04	1361.	5.15	100.17	74.70	18.68	91.86	68.50	14.72	10.98	16.03	20415.	77.25	4.25	1.30	19.9	1.07	11.41	22.0	1.013	0.0002338	0.00002172	17359.	18440.
90	769	2.723	0.83	39.6	12.06	1267.	4.80	99.77	74.40	18.60	91.48	68.22	12.69	9.46	13.87	19005.	72.00	3.96	1.21	19.9	2.78	10.35	42.0	1.010	0.0004441	0.00004126	8505.	9035.
105	748	2.723	0.83	37.9	11.54	1173.	4.44	91.19	68.00	17.00	83.63	62.36	11.24	8.38	13.44	17595.	66.60	3.68	1.12	20.1	2.07	10.09	45.0	1.016	0.0004767	0.00004429	7333.	7790.
120	675	2.723	0.83	29.5	8.99	722.	2.73	77.38	57.70	14.43	70.95	52.91	5.38	4.01	7.58	10830.	40.95	2.26	0.69	19.5	2.58	16.03	30.0	1.010	0.0003197	0.00002970	6737.	7156.
135	796	2.526	0.77	62.1	18.92	1361.	5.15	104.87	78.20	19.55	96.16	71.71	21.36	15.93	22.21	20415.	77.25	4.25	1.30	18.2	1.76	13.01	12.0	1.014	0.0001273	0.00001183	31857.	33840.
150	796	2.526	0.77	51.7	15.75	1361.	5.15	104.73	78.10	19.53	96.04	71.62	17.78	13.26	18.51	20415.	77.25	4.25	1.30	19.1	1.00	0.84	13.0	1.004	0.0001394	0.00001295	29116.	30929.
165	795	2.526	0.77	51.0	15.55	1361.	5.15	111.71	83.30	20.83	102.44	76.39	17.55	13.09	17.14	20415.	77.25	4.25	1.30	19.1	1.44	0.27	7.5	1.008	0.0000801	0.00000744	50669.	53823.
180	796	2.526	0.77	57.7	17.59	1214.	4.60	110.37	82.30	20.58	101.21	75.47	17.74	13.23	17.53	18210.	69.00	3.82	1.16	19.3	2.02	7.70	7.0	1.009	0.0000747	0.00000694	48498.	51508.
AVG.	766	2.615	0.80	45.9	13.99	1263.	4.78	100.25	74.76	18.69	91.93	68.55	14.93	11.13	15.96	18939.	71.70	3.95	1.21	19.2	2.54	15.68	38.1	1.013	0.0004016	0.00003731	22972.	24402.

* 75th minute data deleted, since flow rate of the slurry was approaching 0.
• Belts on motor were slipping.

800 rpm, 0.5 inch clearance
Pipeline length 436.5 m
(Valve approx. 30% open)

TEST No.1, RUN No.1
DATE: JULY 26, & 28 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

TIME	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.0045	1.757	0.1409	0.1150	0.0272	0.0347	0.0224	0.0354	0.0125	0.0284	0.0264	3.026	107.619	6.370	5.240	0.910	1.163	0.751	1.104	0.419	0.949	0.805
45	0.0510	2.560	0.1696	0.1170	0.0205	0.0315	0.0214	0.0407	0.0004	0.0533	0.0246	2.001	242.540	6.011	4.701	0.610	0.935	0.633	1.200	0.240	1.502	0.732
60	0.0201	2.309	0.1696	0.1029	0.0205	0.0315	0.0292	0.0244	0.0004	0.0533	0.0246	0.005	226.349	6.011	4.132	0.610	0.935	0.066	0.725	0.240	1.502	0.732
90	0.0791	2.403	0.1616	0.1240	0.0276	0.0237	0.0197	0.0469	0.0157	0.0123	0.0245	2.752	203.010	5.622	4.341	0.710	0.609	0.500	1.200	0.404	0.316	0.630
105	0.0070	2.713	0.2240	0.1637	0.0132	0.0429	0.0230	0.0540	0.0155	-.0316	0.0250	2.617	190.794	6.703	4.000	0.290	0.946	0.500	1.200	0.342	-0.696	0.552
120	0.4923	4.052	0.1672	0.3122	0.0960	0.0460	0.0469	0.1126	0.0315	-.1210	0.0570	5.570	129.524	1.092	3.533	0.010	0.391	0.393	0.942	0.264	-1.013	0.477
135	0.1220	4.677	0.1144	0.1170	0.0135	0.0205	0.0097	0.0317	0.0004	0.0107	0.0152	4.099	443.175	4.595	4.731	0.400	0.609	0.209	0.942	0.240	0.316	0.452
150	0.0510	3.440	0.1157	0.0072	0.0135	0.0392	0.0171	0.0407	0.0004	0.0320	0.0229	2.001	326.667	4.649	3.503	0.400	1.163	0.500	1.200	0.240	0.949	0.600
165	0.0605	3.410	0.1144	0.0939	0.0135	0.0392	0.0175	0.0317	0.0031	0.0320	0.0212	2.752	323.010	4.595	3.772	0.400	1.163	0.520	0.942	0.093	0.949	0.630
180	0.1440	5.319	0.1065	0.1236	0.0254	0.0300	0.0060	0.0390	0.0105	0.0134	0.0212	4.631	401.270	3.405	3.952	0.600	0.720	0.162	0.942	0.240	0.316	0.502
AVG.	0.1203	3.362	0.1405	0.1359	0.0272	0.0341	0.0214	0.0459	0.0122	0.0003	0.0263	3.201	267.556	5.146	4.279	0.574	0.064	0.514	1.051	0.276	0.525	0.627

TEST No.1, RUN No.1
DATE: JULY 26, & 28 1984

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

PRESSURE HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
15	12.76	11.64	5.73	4.71	3.69	2.67	1.65	1.35	1.04	0.00
45	13.74	12.86	5.22	4.10	3.30	2.57	1.65	1.34	1.14	0.00
60	13.04	12.35	5.22	4.10	3.30	2.57	1.45	1.34	1.14	0.00
90	12.06	11.03	4.61	3.69	2.87	2.36	1.55	1.24	0.94	0.00
105	11.54	10.52	4.51	3.38	2.98	2.16	1.35	1.04	0.78	0.00
120	8.99	7.46	3.30	3.08	2.16	1.85	1.14	0.94	0.73	0.00
135	18.92	17.65	3.69	2.98	2.47	1.96	1.34	1.14	0.94	0.00
150	15.75	14.98	4.61	3.89	3.38	2.36	1.55	1.24	1.04	0.00
165	15.55	14.40	4.40	3.69	3.18	2.16	1.34	1.14	1.04	0.00
180	17.39	16.33	3.69	3.18	2.47	1.85	1.34	1.14	0.94	0.00
AVG.	13.99	12.93	4.51	3.68	3.00	2.25	1.44	1.19	0.97	0.00

VELOCITY HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
15	0.41	0.25	0.25	0.10	0.10	0.10	0.10	0.10	0.10	0.10
45	0.36	0.22	0.22	0.09	0.09	0.09	0.09	0.09	0.09	0.09
60	0.36	0.22	0.22	0.09	0.09	0.09	0.09	0.09	0.09	0.09
90	0.31	0.19	0.19	0.08	0.08	0.08	0.08	0.08	0.08	0.08
105	0.27	0.16	0.16	0.06	0.06	0.06	0.06	0.06	0.06	0.06
120	0.10	0.06	0.06	0.02	0.02	0.02	0.02	0.02	0.02	0.02
135	0.36	0.22	0.22	0.09	0.09	0.09	0.09	0.09	0.09	0.09
150	0.36	0.22	0.22	0.09	0.09	0.09	0.09	0.09	0.09	0.09
165	0.36	0.22	0.22	0.09	0.09	0.09	0.09	0.09	0.09	0.09
180	0.29	0.18	0.18	0.07	0.07	0.07	0.07	0.07	0.07	0.07
AVG.	0.32	0.19	0.19	0.08	0.08	0.08	0.08	0.08	0.08	0.08

GRAVITATIONAL HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
15	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
45	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
60	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
90	0.00	0.74	0.74	0.73	0.84	0.79	1.16	0.97	1.01	1.90
105	0.00	0.74	0.74	0.73	0.84	0.79	1.16	0.97	1.01	1.90
120	0.00	0.74	0.74	0.73	0.84	0.79	1.16	0.97	1.01	1.90
135	0.00	0.68	0.68	0.67	0.78	0.73	1.10	0.91	0.95	1.84
150	0.00	0.68	0.68	0.67	0.78	0.73	1.10	0.91	0.95	1.84
165	0.00	0.68	0.68	0.67	0.78	0.73	1.10	0.91	0.95	1.84
180	0.00	0.68	0.68	0.67	0.78	0.73	1.10	0.91	0.95	1.84
AVG.	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87

TOTAL DYNAMIC HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
15	13.17	12.60	6.69	5.51	4.60	3.53	2.88	2.39	2.12	1.97
45	14.10	13.79	6.15	4.89	4.20	3.42	2.87	2.37	2.21	1.96
60	13.40	13.28	6.15	4.89	4.20	3.42	2.67	2.37	2.21	1.96
90	12.37	11.96	5.54	4.50	3.79	3.23	2.79	2.29	2.03	1.98
105	11.81	11.42	5.41	4.17	3.88	3.01	2.57	2.07	1.85	1.96
120	9.09	8.26	4.10	3.83	3.02	2.66	2.32	1.93	1.76	1.92
135	19.28	18.55	4.59	3.74	3.34	2.78	2.53	2.14	1.98	1.93
150	16.11	15.88	5.51	4.65	4.25	3.18	2.74	2.24	2.08	1.93
165	15.91	15.30	5.30	4.45	4.05	2.98	2.53	2.14	2.08	1.93
180	17.68	17.19	4.55	3.92	3.32	2.65	2.51	2.12	1.96	1.91
AVG.	14.31	13.84	5.41	4.46	3.88	3.09	2.64	2.21	2.03	1.95

TEST No.1, RUN No.2
DATE: JULY 20 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP																PEAT SLURRY PIPELINE										
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
15	796	2.461	0.75	62.7	19.10	900.	3.41	107.95	80.50	20.13	98.99	73.82	14.28	10.65	14.43	13500.	51.15	2.83	0.86	19.7	1.16	5.92	5.5	1.010	0.0000587	0.00000545	45799.	48658.
30	795	2.461	0.75	62.7	19.10	900.	3.41	107.95	80.50	20.13	98.99	73.82	14.28	10.65	14.43	13500.	51.15	2.83	0.86	20.0	1.62	6.36	6.5	1.000	0.0000694	0.00000645	38676.	41084.
45	795	2.461	0.75	67.7	20.63	900.	3.41	106.21	79.20	19.80	97.40	72.63	15.42	11.50	15.83	13500.	51.15	2.83	0.86	19.7	1.40	8.14	8.0	1.010	0.0000852	0.00000792	31487.	33447.
60	796	2.559	0.78	67.8	20.66	953.	3.61	107.55	80.20	20.05	98.62	73.54	16.35	12.19	16.58	14295.	54.15	2.97	0.91	20.0	1.95	3.79	7.0	1.006	0.0000749	0.00000696	37926.	40287.
75	796	2.559	0.78	68.8	20.97	900.	3.41	107.95	80.50	20.13	98.99	73.82	15.68	11.69	15.84	13500.	51.15	2.83	0.86	20.1	1.49	5.03	7.0	1.010	0.0000746	0.00000693	35985.	38225.
90	796	2.559	0.78	69.1	21.07	900.	3.41	106.61	79.50	19.88	97.76	72.90	15.76	11.75	16.12	13500.	51.15	2.83	0.86	20.1	1.15	4.47	7.0	1.011	0.0000745	0.00000692	36028.	38263.
105	796	2.559	0.78	68.4	20.86	900.	3.41	100.98	75.30	18.83	92.60	69.05	15.60	11.63	16.84	13500.	51.15	2.83	0.86	20.3	1.30	6.26	7.0	1.000	0.0000747	0.00000694	35914.	38149.
120	795	2.559	0.78	66.4	20.25	900.	3.41	103.80	77.40	19.35	95.19	70.98	15.14	11.29	15.91	13500.	51.15	2.83	0.86	20.3	1.52	7.40	8.5	1.009	0.0000906	0.00000842	29685.	31448.
135	795	2.625	0.80	64.5	19.66	900.	3.41	109.16	81.40	20.35	100.09	74.64	14.70	10.96	14.68	13500.	51.15	2.83	0.86	19.0	1.20	7.00	6.0	1.006	0.0000642	0.00000596	41816.	44419.
150	796	2.625	0.80	62.5	19.05	995.	3.76	106.21	79.20	19.80	97.40	72.63	15.70	11.71	16.12	14925.	56.48	3.11	0.95	20.1	1.01	6.22	7.0	1.012	0.0000745	0.00000692	39829.	42309.
165	795	2.854	0.87	70.1	21.36	900.	3.41	107.55	80.20	20.05	98.62	73.54	15.97	11.91	16.20	13500.	51.15	2.83	0.86	20.0	1.34	8.60	6.0	1.005	0.0000643	0.00000597	41775.	44375.
180	796	2.854	0.87	68.1	20.75	900.	3.41	106.61	79.50	19.88	97.76	72.90	15.52	11.57	15.87	13500.	51.15	2.83	0.86	20.4	1.27	11.25	6.0	1.006	0.0000642	0.00000596	41816.	44419.
AVG.	796	2.595	0.79	66.6	20.29	912.	3.46	106.54	79.45	19.87	97.70	72.86	15.37	11.46	15.74	13685.	51.80	2.87	0.87	20.0	1.30	6.76	6.0	1.000	0.0000725	0.00000674	38068.	40438.

800 rpm, 0.5 inch clearance
Pipeline length 436.5 m

TEST No.1, RUN No.2
DATE: JULY 28 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
				AVG. FRICT.							AVG. FRICT.				AVG. HEAD							AVG. HEAD
	RUBBER HOSE AND VALVE SKID			FACTOR	12" PIPELINE						FACTOR	RUBBER HOSE AND VALVE SKID			LOSS m/100m	12" PIPELINE						LOSS m/100m
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE	BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4	RUBBER HOSE	BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.2444	11.629	0.1169	0.1737	0.0146	0.0301	0.0036	0.0725	0.0191	0.0243	0.0229	4.295	482.222	2.054	3.054	0.190	0.391	0.046	0.942	0.248	0.316	0.297
30	0.2062	11.703	0.1015	0.1482	0.0185	0.0217	0.0036	0.0725	0.0191	0.0243	0.0219	3.624	488.571	1.784	2.605	0.240	0.283	0.046	0.942	0.248	0.316	0.285
45	0.4009	12.334	0.1445	0.2589	0.0154	0.0385	0.0036	0.0725	0.0323	-.0292	0.0250	7.047	511.429	2.541	4.551	0.200	0.500	0.046	0.942	0.419	-0.380	0.325
60	0.3274	11.084	0.1318	0.2191	0.0069	0.0344	0.0024	0.0830	0.0171	0.0217	0.0223	6.443	514.603	2.595	4.311	0.100	0.500	0.035	1.208	0.248	0.316	0.325
75	0.3627	12.724	0.1322	0.2351	0.0108	0.0385	0.0036	0.0725	0.0191	0.0243	0.0238	6.376	527.619	2.324	4.132	0.140	0.500	0.046	0.942	0.248	0.316	0.310
90	0.4009	12.724	0.1322	0.2521	0.0185	0.0301	-.0062	0.0929	0.0191	0.0243	0.0238	7.047	527.619	2.324	4.431	0.240	0.391	-0.081	1.208	0.248	0.316	0.310
105	0.3207	12.724	0.1322	0.2163	0.0108	0.0385	0.0036	0.0725	0.0323	-.0292	0.0238	5.630	527.619	2.324	3.802	0.140	0.500	0.046	0.942	0.419	-0.380	0.310
120	0.4391	12.096	0.1169	0.2606	0.0146	0.0385	0.0036	0.0539	0.0323	-.0292	0.0229	7.710	501.587	2.054	4.581	0.190	0.500	0.046	0.700	0.419	-0.380	0.297
135	0.4773	11.629	0.1169	0.2776	0.0146	0.0301	0.0036	0.0725	0.0203	-.0292	0.0210	8.389	482.222	2.054	4.880	0.190	0.391	0.046	0.942	0.264	-0.380	0.272
150	0.3974	8.759	0.1487	0.2596	0.0126	0.0308	0.0029	0.0609	0.0255	0.0599	0.0236	8.523	443.175	3.189	5.569	0.200	0.489	0.046	0.966	0.404	0.949	0.375
165	0.5574	12.250	0.1630	0.3390	0.0192	0.0376	0.0036	0.0743	0.0311	0.0730	0.0298	9.799	507.937	2.865	5.958	0.250	0.489	0.046	0.966	0.404	0.949	0.387
180	0.4391	12.096	0.1476	0.2776	0.0231	0.0293	0.0311	0.0539	0.0072	0.0730	0.0288	7.710	501.587	2.595	4.880	0.300	0.380	0.404	0.700	0.093	0.949	0.375
AVG.	0.3811	11.819	0.1320	0.2432	0.0150	0.0332	0.0049	0.0712	0.0229	0.0173	0.0241	6.885	501.349	2.392	4.396	0.198	0.443	0.064	0.950	0.305	0.242	0.322

TEST No.1, RUN No.2
DATE: JULY 28 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

PRESSURE HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	19.10	17.86	2.67	2.36	2.06	1.75	1.34	1.14	0.94	0.00
30	19.10	17.96	2.57	2.31	1.96	1.75	1.34	1.14	0.94	0.00
45	20.63	18.98	2.87	2.47	2.16	1.75	1.34	1.14	0.83	0.00
60	20.66	19.08	2.87	2.47	2.26	1.85	1.45	1.14	0.94	0.00
75	20.97	19.39	2.77	2.41	2.16	1.75	1.34	1.14	0.94	0.00
90	21.07	19.39	2.77	2.41	2.06	1.75	1.45	1.14	0.94	0.00
105	20.86	19.39	2.77	2.41	2.16	1.75	1.34	1.14	0.83	0.00
120	20.25	18.47	2.67	2.36	2.06	1.65	1.24	1.14	0.83	0.00
135	19.66	17.76	2.57	2.26	1.96	1.65	1.24	1.04	0.83	0.00
150	19.05	17.14	3.18	2.67	2.36	1.96	1.55	1.34	1.04	0.00
165	21.36	19.18	3.18	2.72	2.36	1.96	1.55	1.34	1.04	0.00
180	20.75	18.88	3.08	2.67	2.26	1.96	1.24	1.14	1.04	0.00
AVG.	20.29	18.62	2.83	2.46	2.15	1.79	1.37	1.17	0.93	0.00

VELOCITY HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
30	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
45	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
60	0.18	0.11	0.11	0.04	0.04	0.04	0.04	0.04	0.04	0.04
75	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
90	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
105	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
120	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
135	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
150	0.19	0.12	0.12	0.05	0.05	0.05	0.05	0.05	0.05	0.05
165	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
180	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04
AVG.	0.16	0.10	0.10	0.04	0.04	0.04	0.04	0.04	0.04	0.04

GRAVITATIONAL HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	0.00	0.66	0.66	0.65	0.76	0.71	1.08	0.89	0.93	1.82
30	0.00	0.66	0.66	0.65	0.76	0.71	1.08	0.89	0.93	1.82
45	0.00	0.66	0.66	0.65	0.76	0.71	1.08	0.89	0.93	1.82
60	0.00	0.69	0.69	0.68	0.79	0.74	1.11	0.92	0.96	1.85
75	0.00	0.69	0.69	0.68	0.79	0.74	1.11	0.92	0.96	1.85
90	0.00	0.69	0.69	0.68	0.79	0.74	1.11	0.92	0.96	1.85
105	0.00	0.69	0.69	0.68	0.79	0.74	1.11	0.92	0.96	1.85
120	0.00	0.69	0.69	0.68	0.79	0.74	1.11	0.92	0.96	1.85
135	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
150	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
165	0.00	0.78	0.78	0.77	0.88	0.83	1.20	1.01	1.05	1.94
180	0.00	0.78	0.78	0.77	0.88	0.83	1.20	1.01	1.05	1.94
AVG.	0.00	0.70	0.70	0.69	0.80	0.75	1.12	0.93	0.97	1.86

TOTAL DYNAMIC HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	19.26	18.62	3.43	3.05	2.86	2.50	2.46	2.07	1.91	1.86
30	19.26	18.72	3.33	3.00	2.76	2.50	2.46	2.07	1.91	1.86
45	20.79	19.74	3.63	3.16	2.96	2.50	2.46	2.07	1.80	1.86
60	20.84	19.88	3.67	3.19	3.09	2.63	2.60	2.10	1.94	1.89
75	21.13	20.18	3.56	3.13	2.99	2.53	2.49	2.10	1.94	1.89
90	21.23	20.18	3.56	3.13	2.89	2.53	2.60	2.10	1.94	1.89
105	21.02	20.18	3.56	3.13	2.99	2.53	2.49	2.10	1.83	1.89
120	20.41	19.26	3.46	3.08	2.89	2.43	2.39	2.10	1.83	1.89
135	19.82	18.57	3.38	3.00	2.81	2.45	2.41	2.02	1.85	1.91
150	19.24	17.97	4.01	3.42	3.22	2.77	2.73	2.33	2.07	1.92
165	21.52	20.06	4.06	3.53	3.28	2.83	2.79	2.39	2.13	1.98
180	20.91	19.76	3.96	3.48	3.18	2.83	2.48	2.19	2.13	1.98
AVG.	20.45	19.43	3.63	3.19	2.99	2.59	2.53	2.14	1.94	1.90

TEST No.1, RUN No.3
DATE: JULY 20 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP																PEAT SLURRY PIPELINE										
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
---	----	-.---	-.--	---.-	--.--	----.	----.--	---.--	---.--	--.--	---.--	---.--	---.--	---.--	---.--	-------.	---.--	--.--	-.--	--.-	-.--	--.--	---.-	-.---	-.-------	-.--------	-------.	-------.
15	787	3.150	0.96	34.3	10.45	2261.	8.56	111.04	82.80	20.70	101.82	75.93	19.62	14.63	19.27	33915.	123.90	7.10	2.16	22.2	1.30	6.20	5.0	1.011	0.0000533	0.00000495	126650.	134543.
30	787	3.150	0.96	33.3	10.15	2167.	8.20	112.30	83.80	20.95	103.04	76.84	18.25	13.61	17.71	32585.	123.00	6.80	2.07	21.6	2.99	20.80	21.5	1.015	0.0002280	0.00002110	28340.	30104.
45	787	3.609	1.10	33.1	10.09	2136.	8.08	108.62	81.00	20.25	99.61	74.28	17.88	13.33	17.95	32040.	121.28	6.70	2.04	20.4	2.59	17.90	24.0	1.017	0.0002540	0.00002360	25869.	26630.
75	787	3.609	1.10	40.5	12.34	2293.	8.68	131.55	98.10	24.53	120.64	89.96	23.48	17.51	19.46	34395.	130.20	7.20	2.19	21.1	3.72	22.50	26.5	1.024	0.0002786	0.00002588	24541.	26069.
90	792	3.281	1.00	31.8	9.68	1591.	6.02	107.42	80.10	20.03	98.50	73.45	12.78	9.53	12.97	23865.	90.30	5.00	1.52	18.0	2.22	29.62	21.0	1.017	0.0002223	0.00002065	21347.	22676.
105	792	3.281	1.00	33.4	10.19	1497.	5.67	103.80	77.40	19.35	95.19	70.98	12.67	9.45	13.31	22455.	85.05	4.70	1.43	17.4	2.76	32.11	80.0	1.019	0.0008451	0.00007851	5202.	5611.
120	793	3.281	1.00	26.8	8.17	1529.	5.79	105.00	78.30	19.58	96.29	71.80	10.37	7.73	10.77	22935.	86.80	4.80	1.46	17.1	4.31	49.17	42.0	1.030	0.0004389	0.00004078	10383.	11038.
135	792	3.445	1.05	30.3	9.24	1497.	5.67	103.93	77.50	19.38	95.31	71.07	11.49	8.57	12.06	22455.	85.05	4.70	1.43	17.4	3.75	46.33	81.0	1.020	0.0008481	0.00007879	5263.	5591.
150	792	3.445	1.05	28.3	8.63	1371.	5.19	99.91	74.50	18.63	91.62	68.32	9.82	7.32	10.71	20565.	86.40	4.30	1.31	17.1	4.01	49.63	47.0	1.032	0.0004902	0.00004554	8342.	8861.
165	792	3.445	1.05	31.9	9.73	1696.	6.42	113.85	84.90	21.23	104.48	77.85	13.69	10.21	13.11	25440.	96.30	5.30	1.62	17.1	2.05	37.85	50.0	1.019	0.0005282	0.00004907	9575.	10171.
180	792	3.445	1.05	25.9	7.90	1560.	5.90	109.03	81.30	20.33	99.97	74.55	10.22	7.62	10.22	23400.	89.70	4.90	1.49	16.5	3.13	40.60	41.0	1.022	0.0004318	0.00004012	10771.	11441.
195	792	3.470	1.06	22.0	6.70	1309.	4.95	99.24	74.00	18.50	91.00	67.86	7.27	5.42	7.99	19635.	74.25	4.10	1.25	16.4	3.62	31.76	41.0	1.030	0.0004285	0.00003981	9107.	9674.
210	792	3.470	1.06	27.6	8.42	1654.	6.26	99.10	73.90	18.48	90.88	67.77	11.56	8.62	12.72	24810.	93.90	5.20	1.58	16.5	2.29	30.09	20.0	1.019	0.0002950	0.00002740	16675.	17713.
AVG.	791	3.392	1.03	30.7	9.36	1735.	6.57	108.87	80.50	20.15	99.18	73.90	13.78	10.27	13.71	26832.	98.55	5.45	1.66	18.7	3.02	29.07	36.4	1.021	0.0003833	0.00003561	26916.	28592.

* 60th minute data deleted, since flow rate of the slurry was approaching 0.
Belts on motor were slipping.

800 rpm, 0.5 inch clearance
Pipeline length 436.5 m
(Valve full open)

TEST No.1, RUN No.3
DATE: JULY 20 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
15	0.0593	0.024	0.0682	0.0643	0.0185	0.0251	0.0163	0.0236	0.0127	0.0432	0.0201	6.577	6.349	7.560	7.126	1.520	2.054	1.339	1.932	1.040	3.544	1.649
30	0.1166	0.026	0.0560	0.0835	0.0189	0.0212	0.0170	0.0160	0.0159	0.0307	0.0192	11.079	6.349	5.704	8.503	1.420	1.590	1.339	1.200	1.196	2.911	1.444
45	0.1120	0.056	0.0574	0.0817	0.0200	0.0285	0.0199	0.0132	0.0121	0.0303	0.0187	11.074	13.016	5.676	8.004	1.520	1.500	1.455	0.966	0.885	2.215	1.369
75	0.1437	0.037	0.0763	0.1064	0.0205	0.0230	0.0159	0.0201	0.0142	0.0345	0.0196	16.376	9.041	8.703	12.126	1.730	1.935	1.339	1.691	1.196	2.911	1.649
90	0.1222	0.125	0.1090	0.1592	0.0224	0.0369	0.0270	0.0297	0.0210	0.0390	0.0281	6.711	16.190	10.370	8.743	0.910	1.500	1.097	1.200	0.885	1.582	1.139
105	0.2044	0.197	0.1660	0.1036	0.0309	0.0417	0.0273	0.0329	0.0294	0.0440	0.0331	9.933	22.540	8.100	8.922	1.110	1.500	0.982	1.184	1.056	1.582	1.189
120	0.0649	0.080	0.1611	0.1102	0.0270	0.0281	0.0293	0.0322	0.0270	0.0084	0.0277	3.209	9.524	8.162	5.980	1.010	1.054	1.097	1.208	1.040	0.316	1.037
135	0.1229	0.111	0.2236	0.1707	0.0139	0.0304	0.0341	0.0336	0.0289	0.0264	0.0289	5.973	12.690	10.063	8.603	0.500	1.300	1.224	1.208	1.048	0.949	1.037
150	0.1744	0.033	0.2770	0.2312	0.0232	0.0202	0.0444	0.0320	0.0293	0.0315	0.0293	7.114	3.175	11.297	9.431	0.700	0.609	1.339	0.966	0.885	0.949	0.885
165	0.0215	0.110	0.2037	0.1224	0.0206	0.0252	0.0290	0.0257	0.0229	0.0343	0.0269	1.342	16.190	12.703	7.633	1.320	1.163	1.339	1.184	1.056	1.582	1.242
180	-.0165	0.105	0.1752	0.0997	0.0233	0.0326	0.0281	0.0240	0.0187	0.0406	0.0266	-0.872	13.016	9.243	4.731	0.910	1.272	1.097	0.966	0.730	1.582	1.037
195	0.0596	0.112	0.1600	0.1201	0.0255	0.0222	0.0320	0.0343	0.0322	0.0115	0.0276	2.215	9.041	6.270	4.461	0.700	0.609	0.878	0.942	0.885	0.316	0.757
210	-.0124	0.070	0.1505	0.0823	0.0324	0.0230	0.0226	0.0270	0.0276	0.0361	0.0271	-0.730	9.041	9.405	4.000	1.420	1.043	0.993	1.184	1.211	1.582	1.189
AVG.	0.0902	0.084	0.1525	0.1247	0.0235	0.0276	0.0264	0.0265	0.0226	0.0322	0.0256	6.221	11.420	8.702	7.639	1.136	1.324	1.194	1.219	1.000	1.694	1.282

TEST No.1, RUN No.3
DATE: JULY 28 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
15	10.45	8.99	8.79	7.77	6.14	4.30	2.77	2.16	1.45	0.00	1.00	0.61	0.61	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.00	0.87	0.87	0.86	0.97	0.92	1.29	1.10	1.14	2.03	11.45	10.47	10.27	8.87	7.35	5.46	4.30	3.50	2.83	2.27
30	10.15	7.87	7.67	6.95	5.42	4.00	2.47	2.16	1.35	0.00	0.92	0.56	0.56	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	0.87	0.87	0.86	0.97	0.92	1.29	1.10	1.14	2.03	11.07	9.30	9.10	8.03	6.61	5.14	3.98	3.48	2.71	2.25
45	10.09	7.77	7.36	6.65	5.02	3.69	2.06	1.85	1.24	0.00	0.89	0.55	0.55	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	1.01	1.01	1.00	1.11	1.06	1.43	1.24	1.28	2.17	10.90	9.33	8.92	7.87	6.35	4.97	3.71	3.31	2.74	2.39
75	12.34	9.30	8.99	7.77	5.93	4.20	2.67	2.16	1.35	0.00	1.04	0.63	0.63	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.00	1.01	1.01	1.00	1.11	1.06	1.43	1.24	1.28	2.17	13.30	10.94	10.63	9.02	7.29	5.51	4.35	3.65	2.88	2.42
90	9.60	7.97	7.46	5.73	4.71	3.38	2.06	1.75	1.14	0.00	0.50	0.30	0.30	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.91	0.91	0.90	1.01	0.96	1.33	1.14	1.18	2.07	10.10	9.18	8.67	6.75	5.84	4.46	3.51	3.01	2.44	2.19
105	10.19	7.97	7.26	5.93	4.71	3.38	2.16	1.86	1.14	0.00	0.44	0.27	0.27	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.00	0.91	0.91	0.90	1.01	0.96	1.33	1.14	1.18	2.07	10.63	9.15	8.44	6.94	5.83	4.45	3.60	3.11	2.43	2.18
120	8.17	6.95	6.65	5.32	4.20	3.28	1.96	1.65	0.94	0.00	0.46	0.28	0.28	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.00	0.91	0.91	0.90	1.01	0.96	1.33	1.14	1.18	2.07	8.63	8.14	7.84	6.33	5.32	4.35	3.40	2.90	2.23	2.18
135	9.24	7.56	7.16	5.32	4.71	3.49	2.06	1.75	1.04	0.00	0.44	0.27	0.27	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.00	0.96	0.96	0.95	1.06	1.01	1.38	1.19	1.23	2.12	9.68	8.79	8.39	6.38	5.88	4.61	3.55	3.05	2.38	2.23
150	8.63	6.75	6.65	4.71	3.90	3.39	1.86	1.65	1.04	0.00	0.37	0.23	0.23	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.00	0.96	0.96	0.95	1.06	1.01	1.38	1.19	1.23	2.12	9.00	7.94	7.84	5.75	5.05	4.49	3.33	2.93	2.36	2.21
165	9.73	8.79	8.28	6.14	4.71	3.69	2.16	1.86	1.14	0.00	0.56	0.34	0.34	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.00	0.96	0.96	0.95	1.06	1.01	1.38	1.19	1.23	2.12	10.29	10.09	9.58	7.23	5.91	4.84	3.68	3.19	2.51	2.26
180	7.90	7.26	6.85	5.32	4.30	3.18	1.86	1.65	1.14	0.00	0.40	0.29	0.29	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.96	0.96	0.95	1.06	1.01	1.38	1.19	1.23	2.12	8.30	8.51	8.10	6.39	5.48	4.31	3.36	2.96	2.49	2.24
195	6.70	5.53	5.22	4.20	3.39	2.80	1.75	1.55	0.94	0.00	0.34	0.21	0.21	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.00	0.97	0.97	0.96	1.07	1.02	1.39	1.20	1.24	2.13	7.04	6.71	6.40	5.24	4.54	3.90	3.22	2.83	2.26	2.21
210	8.42	7.77	7.46	5.93	4.40	3.49	2.26	1.96	1.14	0.00	0.54	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.97	0.97	0.96	1.07	1.02	1.39	1.20	1.24	2.13	8.96	9.07	8.75	7.02	5.60	4.64	3.78	3.29	2.51	2.26
AVG.	9.36	7.73	7.37	5.90	4.73	3.57	2.16	1.85	1.16	0.00	0.61	0.37	0.37	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.00	0.94	0.94	0.93	1.04	0.99	1.36	1.17	1.21	2.10	9.97	9.05	8.69	7.06	5.93	4.71	3.67	3.17	2.52	2.25

TEST No.1, RUN No.4
DATE: AUGUST 1 1984

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

PEAT SLURRY PUMP

PEAT SLURRY PIPELINE

TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft^2/s	m^2/s	12" PIPELINE	RUBBER HOSE
15	796	3.937	1.20	37.8	11.51	1853.	7.01	108.09	80.60	20.15	99.11	73.91	17.69	13.19	17.85	27795.	105.15	5.80	1.77	18.3	1.20	19.65	9.5	1.017	0.0001005	0.00000934	54950.	58371.
30	793	4.134	1.26	34.6	10.55	1884.	7.13	110.37	82.30	20.58	101.21	75.47	16.49	12.30	16.30	28260.	106.95	5.90	1.80	18.2	1.25	24.03	8.0	1.011	0.0000851	0.00000791	65960.	70074.
45	794	4.495	1.37	34.6	10.56	1822.	6.90	108.89	81.20	20.30	99.85	74.46	15.97	11.91	16.00	27330.	103.50	5.70	1.74	19.3	1.23	26.74	8.0	1.015	0.0000848	0.00000788	64021.	68007.
60	793	4.593	1.40	34.4	10.49	1759.	6.66	105.54	78.70	19.68	96.78	72.17	15.31	11.42	15.82	26385.	99.90	5.50	1.68	17.9	1.41	19.27	9.0	1.015	0.0000955	0.00000887	54945.	58366.
75	794	4.757	1.45	38.3	11.68	1727.	6.54	106.48	79.40	19.85	97.64	72.81	16.75	12.49	17.15	25905.	98.10	5.40	1.65	17.5	2.85	42.02	35.0	1.024	0.0003679	0.00003418	14000.	14871.
90	794	4.921	1.50	35.9	10.93	1654.	6.26	103.66	77.30	19.33	95.05	70.88	15.01	11.19	15.79	24810.	93.90	5.20	1.58	17.0	2.75	40.90	30.0	1.038	0.0003135	0.00002913	15732.	16711.
120	793	4.429	1.35	39.6	12.08	1822.	6.90	109.29	81.50	20.38	100.23	74.74	18.28	13.63	18.24	27330.	103.50	5.70	1.74	17.5	1.87	31.76	16.5	1.021	0.0001739	0.00001616	31224.	33168.
150	793	4.101	1.25	31.6	9.62	1591.	6.02	101.11	75.40	18.85	92.72	69.14	12.70	9.47	13.70	23865.	90.30	5.00	1.52	17.7	1.49	23.01	14.0	1.013	0.0001488	0.00001382	31895.	33881.
165	794	4.167	1.27	38.0	11.59	1822.	6.90	109.03	81.30	20.33	99.97	74.55	17.54	13.08	17.55	27330.	103.50	5.70	1.74	17.5	1.47	20.41	16.0	1.021	0.0001687	0.00001567	32200.	34204.
180	793	4.232	1.29	31.0	9.46	1696.	6.42	105.14	78.40	19.60	96.41	71.89	13.32	9.93	13.81	25440.	96.30	5.30	1.62	17.5	1.26	25.95	8.5	1.016	0.0000901	0.00000837	56155.	59651.
195	792	4.232	1.29	30.7	9.35	1560.	5.90	103.63	77.28	19.32	95.04	70.87	12.10	9.02	12.73	23400.	88.50	4.90	1.49	17.0	0.79	10.90	6.0	1.000	0.0000640	0.00000595	72593.	77112.
210	792	4.363	1.33	31.2	9.52	1591.	6.02	111.71	83.30	20.83	102.44	76.39	12.57	9.37	12.27	23865.	90.30	5.00	1.52	17.0	1.80	35.04	12.0	1.023	0.0001263	0.00001173	37570.	39910.
AVG.	793	4.363	1.33	34.8	10.61	1732.	6.56	106.91	79.72	19.93	98.04	73.11	15.31	11.42	15.60	25976.	98.40	5.43	1.65	17.8	1.61	28.05	14.3	1.018	0.0001510	0.00001403	44469.	47237.

* 105th minute data deleted, since flow rate of the slurry was approaching 0
Belts on motor were slipping.

800 rpm, 0.5 inch clearance
Pipeline length 436.5 m

TEST No.1, RUN No.4
DATE: AUGUST 1 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR	12" PIPELINE						AVG. FRICT. FACTOR	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m	12" PIPELINE						AVG. HEAD LOSS m/100m
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE	BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4	RUBBER HOSE	BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.0865	0.184	0.1445	0.1186	0.0276	0.0292	0.0243	0.0307	0.0245	0.0057	0.0262	6.443	32.381	10.757	8.832	1.520	1.609	1.339	1.491	1.351	0.316	1.444
30	0.0845	0.178	0.1250	0.1069	0.0197	0.0302	0.0193	0.0170	0.0237	0.0056	0.0218	6.510	32.381	9.622	8.234	1.120	1.717	1.097	0.966	1.351	0.316	1.242
45	0.0597	0.172	0.1029	0.0836	0.0286	0.0302	0.0273	0.0227	0.0254	0.0059	0.0267	4.295	29.286	7.405	6.010	1.520	1.609	1.455	1.200	1.351	0.316	1.419
60	0.0930	0.163	0.1257	0.1067	0.0206	0.0360	0.0190	0.0195	0.0272	0.0064	0.0265	5.570	25.714	8.432	7.156	1.420	1.826	0.982	0.966	1.351	0.316	1.317
75	0.1297	0.191	0.2063	0.1721	0.0190	0.0359	0.0256	0.0197	0.0310	0.0066	0.0260	8.389	29.286	13.351	11.138	0.910	1.717	1.224	0.942	1.522	0.316	1.242
90	0.1063	0.209	0.1676	0.1403	0.0253	0.0468	0.0224	0.0187	0.0294	0.0072	0.0289	6.389	29.286	9.946	8.323	1.110	2.034	0.982	0.821	1.209	0.316	1.267
120	0.0700	0.211	0.1071	0.1340	0.0304	0.0323	0.0252	0.0177	0.0286	0.0059	0.0271	5.034	35.873	13.459	9.701	1.620	1.717	1.339	0.942	1.522	0.316	1.444
150	0.0831	0.025	0.2796	0.1919	0.0224	0.0313	0.0245	0.0173	0.0294	0.0070	0.0249	4.564	3.175	15.351	10.539	0.910	1.272	0.993	0.700	1.196	0.316	1.012
165	0.0909	0.191	0.1795	0.1436	0.0209	0.0323	0.0252	0.0132	0.0286	0.0170	0.0247	7.114	32.381	12.919	10.329	1.110	1.717	1.339	0.700	1.522	0.949	1.317
180	0.0764	0.177	0.0797	0.0782	0.0219	0.0349	0.0290	0.0152	0.0364	0.0069	0.0275	4.765	26.032	4.973	4.880	1.010	1.609	1.339	0.700	1.677	0.316	1.267
195	0.0585	0.235	0.1444	0.1061	0.0313	0.0290	0.0281	0.0180	0.0390	0.0081	0.0292	3.887	29.286	7.622	5.599	1.220	1.163	1.097	0.700	1.522	0.316	1.139
210	0.0868	0.250	0.1191	0.1047	0.0300	0.0257	0.0273	0.0232	0.0375	0.0070	0.0281	4.765	32.381	6.541	5.749	1.220	1.043	1.109	0.942	1.522	0.316	1.139
AVG.	0.0853	0.182	0.1551	0.1240	0.0255	0.0330	0.0240	0.0194	0.0301	0.0076	0.0265	5.570	28.095	10.032	8.042	1.224	1.580	1.191	0.840	1.431	0.369	1.271

TEST No.1, RUN No.4
DATE: AUGUST 1 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
---	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	11.51	9.70	8.68	6.95	5.32	3.89	2.36	1.85	0.94	0.00	0.67	0.41	0.41	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.00	1.11	1.11	1.10	1.21	1.16	1.53	1.34	1.38	2.27	12.18	11.22	10.20	8.21	6.69	5.21	4.05	3.35	2.48	2.43
30	10.55	8.68	7.66	6.14	4.91	3.38	2.06	1.85	0.94	0.00	0.69	0.42	0.42	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.00	1.17	1.17	1.16	1.27	1.22	1.59	1.40	1.44	2.33	11.24	10.27	9.25	7.47	6.35	4.77	3.82	3.42	2.55	2.50
45	10.56	8.89	7.97	6.85	5.22	3.79	2.16	1.85	0.94	0.00	0.65	0.40	0.40	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.00	1.28	1.28	1.27	1.38	1.33	1.70	1.51	1.55	2.44	11.21	10.57	9.65	8.28	6.76	5.28	4.02	3.52	2.65	2.60
60	10.49	8.58	7.77	6.44	4.91	3.28	2.06	1.85	0.94	0.00	0.60	0.37	0.37	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.00	1.31	1.31	1.30	1.41	1.36	1.73	1.54	1.58	2.47	11.09	10.26	9.45	7.89	6.47	4.79	3.94	3.54	2.67	2.62
75	11.68	9.30	8.38	6.14	5.12	3.59	2.16	1.96	0.94	0.00	0.59	0.36	0.36	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.00	1.36	1.36	1.35	1.46	1.41	1.78	1.59	1.63	2.52	12.27	11.02	10.10	7.63	6.72	5.14	4.08	3.69	2.71	2.66
90	10.93	8.79	7.87	6.24	5.02	3.18	1.96	1.81	0.94	0.00	0.54	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	1.41	1.41	1.40	1.51	1.46	1.83	1.64	1.68	2.57	11.47	10.53	9.61	7.77	6.66	4.77	3.92	3.58	2.75	2.70
120	12.08	10.32	9.19	6.95	5.22	3.69	2.16	1.96	0.94	0.00	0.65	0.40	0.40	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.00	1.26	1.26	1.25	1.36	1.31	1.68	1.49	1.53	2.42	12.73	11.98	10.85	8.36	6.74	5.16	4.00	3.61	2.63	2.58
150	9.62	7.97	7.87	5.22	4.20	3.08	1.85	1.75	0.94	0.00	0.49	0.30	0.30	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	1.16	1.16	1.15	1.26	1.21	1.58	1.39	1.43	2.32	10.11	9.43	9.33	6.49	5.58	4.41	3.55	3.26	2.49	2.44
165	11.59	9.60	8.58	6.44	5.22	3.69	2.16	2.06	1.04	0.00	0.65	0.40	0.40	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.00	1.18	1.18	1.17	1.28	1.23	1.60	1.41	1.45	2.34	12.24	11.18	10.16	7.77	6.66	5.08	3.92	3.63	2.65	2.50
180	9.46	7.77	6.95	6.24	5.12	3.69	2.16	2.06	0.94	0.00	0.56	0.34	0.34	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.00	1.20	1.20	1.19	1.30	1.25	1.62	1.43	1.47	2.36	10.02	9.31	8.49	7.57	6.56	5.08	3.92	3.63	2.55	2.50
195	9.35	7.87	6.95	5.73	4.40	3.38	2.06	1.96	0.94	0.00	0.47	0.29	0.29	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.00	1.20	1.20	1.19	1.30	1.25	1.62	1.43	1.47	2.36	9.82	9.36	8.44	7.03	5.81	4.74	3.79	3.50	2.52	2.47
210	9.52	7.77	6.75	5.73	4.40	3.49	2.16	1.96	0.94	0.00	0.50	0.30	0.30	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	1.24	1.24	1.23	1.34	1.29	1.66	1.47	1.51	2.40	10.02	9.31	8.29	7.08	5.86	4.90	3.94	3.55	2.57	2.52
AVG.	10.61	8.77	7.89	6.26	4.92	3.51	2.11	1.91	0.95	0.00	0.59	0.36	0.36	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.00	1.24	1.24	1.23	1.34	1.29	1.66	1.47	1.51	2.40	11.20	10.37	9.49	7.63	6.41	4.94	3.91	3.52	2.60	2.54

TEST No.2, RUN No.5
DATE: AUGUST 10 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP																		PEAT SLURRY PIPELINE								
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s		
15	1043	2.133	0.65	74.1	22.58	3036.	11.49	253.72	189.20	47.30	235.97	175.96	56.89	42.42	24.11	45540.	172.35	9.50	2.90	18.7	1.49	16.25	10.5	1.020	0.0001108	0.00001029	81697.	86783.
30	1044	2.133	0.65	45.6	13.91	2397.	9.08	240.45	179.30	44.83	223.62	166.75	27.69	20.65	12.38	35955.	136.20	7.50	2.29	17.0	1.62	21.24	17.0	1.017	0.0001800	0.00001672	39729.	42202.
45	1045	2.297	0.70	47.5	14.47	2429.	9.19	242.72	181.00	45.25	225.73	168.33	29.15	21.74	12.92	36435.	137.85	7.60	2.32	17.9	1.55	19.50	16.0	1.019	0.0001690	0.00001570	42849.	45516.
60	1041	2.297	0.70	49.1	14.98	2429.	9.19	243.00	181.00	45.45	226.73	169.07	30.19	22.51	13.31	36435.	137.85	7.60	2.32	18.0	1.65	21.92	26.5	1.013	0.0002816	0.00002616	25719.	27320.
75	1041	2.625	0.80	44.5	13.57	2230.	8.44	223.01	166.30	41.58	207.40	154.66	25.12	18.73	12.11	33450.	126.60	7.00	2.13	17.6	2.07	36.60	55.0	1.031	0.0005742	0.00005335	11579.	12300.
90	1039	2.625	0.80	56.2	17.14	2492.	9.43	240.90	179.70	44.93	224.11	167.12	35.44	26.43	15.81	37380.	141.45	7.80	2.38	16.7	3.31	32.25	63.0	1.027	0.0006602	0.00006134	11251.	11952.
105	1042	2.625	0.80	46.2	14.08	2261.	8.56	225.56	168.20	42.05	209.78	156.43	26.43	19.71	12.60	33915.	128.40	7.10	2.16	16.6	3.07	27.47	68.0	1.027	0.0007127	0.00006621	9468.	10049.
120	1044	2.297	0.70	42.5	12.96	2199.	8.32	220.20	164.20	41.05	204.79	152.71	23.64	17.63	11.54	32985.	124.80	6.90	2.10	17.0	2.65	33.90	43.5	1.027	0.0004559	0.00004236	14378.	15273.
135	1039	2.297	0.70	60.9	18.56	2617.	9.91	244.20	182.10	45.53	227.10	169.35	40.32	30.07	17.76	39255.	148.65	8.20	2.50	17.0	3.32	25.21	62.0	1.024	0.0006517	0.00006055	11974.	12720.
150	1037	2.395	0.73	69.4	21.14	2869.	10.86	254.39	189.70	47.43	236.58	176.42	50.34	37.54	21.28	43035.	162.90	9.00	2.74	16.7	2.91	35.64	33.5	1.028	0.0003508	0.00003259	24384.	25901.
165	1039	2.395	0.73	54.3	16.54	2492.	9.43	239.91	178.90	44.73	223.12	166.38	34.20	25.50	15.33	37380.	141.45	7.80	2.38	16.9	2.45	27.17	28.5	1.018	0.0003014	0.00002800	24653.	26188.
180	1038	2.526	0.77	52.8	16.08	2335.	8.84	234.95	175.20	43.80	218.51	162.94	31.17	23.24	14.26	35025.	132.60	7.30	2.23	16.8	2.76	28.19	25.0	1.022	0.0002633	0.00002446	26437.	28083.
195	1040	2.709	0.83	44.7	13.61	2293.	8.68	233.47	174.10	43.53	217.12	161.91	25.91	19.32	11.93	34395.	130.20	7.20	2.19	16.9	2.69	27.23	33.5	1.021	0.0003532	0.00003281	19356.	20561.
AVG.	1041	2.410	0.74	52.9	16.12	2468.	9.34	238.26	177.67	44.42	221.58	165.23	33.58	25.04	15.03	37014	140.10	7.73	2.36	17.3	2.47	26.93	36.5	1.023	0.0003831	0.00003559	27684.	29322.

1000 rpm, 0.03 inch clearance
Pipeline length 429.6 m
(Valve full open)

TEST No.2, RUN No.5
DATE: AUGUST 10 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)																HEAD LOSS m/100m							
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	----.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.1323	0.069	0.0700	0.1065	0.0221	0.0265	0.0370	0.0281	0.0210	0.0107	0.0263	26.444	32.381	10.353	21.283	3.260	3.924	5.462	4.155	3.106	1.582	3.891
30	0.0642	0.032	0.0817	0.0630	0.0264	0.0487	0.0241	0.0252	0.0165	0.0172	0.0289	8.000	9.524	7.529	7.849	2.430	4.489	2.217	2.319	1.522	1.582	2.666
45	0.0760	0.043	0.0920	0.0735	0.0474	0.0123	0.0266	0.0309	0.0245	0.0167	0.0282	9.722	13.016	8.706	9.396	4.480	1.163	2.517	2.923	2.314	1.582	2.669
60	0.0895	0.064	0.0920	0.0826	0.0203	0.0416	0.0266	0.0309	0.0245	0.0167	0.0282	11.444	19.365	8.706	10.566	1.920	3.935	2.517	2.923	2.314	1.582	2.666
75	0.0881	0.089	0.1298	0.0906	0.0434	0.0215	0.0211	0.0276	0.0290	0.0198	0.0287	9.500	22.540	10.353	9.774	3.460	1.717	1.686	2.198	2.314	1.582	2.286
90	0.1122	0.122	0.1028	0.1006	0.0009	0.0618	0.0312	0.0294	0.0232	0.0159	0.0286	15.111	38.730	10.235	13.547	0.090	6.152	3.106	2.923	2.314	1.582	2.846
105	0.0957	0.087	0.1722	0.1058	0.0298	0.0345	0.0163	0.0206	0.0379	0.0193	0.0279	10.611	22.857	14.118	11.736	2.440	2.826	1.339	1.691	3.106	1.582	2.286
120	0.0954	0.078	0.1017	0.0889	0.0341	0.0222	0.0097	0.0536	0.0401	0.0204	0.0285	10.000	19.365	7.882	9.321	2.640	1.717	0.751	4.155	3.106	1.582	2.209
135	0.0954	0.082	0.2303	0.1194	0.0361	0.0207	0.0390	0.0220	0.0168	0.0144	0.0278	14.167	28.889	25.294	17.736	3.960	2.272	4.284	2.415	1.848	1.582	3.048
150	0.0987	0.077	0.1008	0.0909	0.0261	0.0340	0.0369	0.0222	0.0235	0.0120	0.0289	17.611	32.381	13.294	16.226	3.450	4.489	4.873	2.923	3.106	1.582	3.813
165	0.1032	0.091	0.1276	0.1003	0.0295	0.0395	0.0135	0.0417	0.0232	0.0159	0.0281	13.889	28.889	12.706	13.509	2.940	3.935	1.339	4.155	2.314	1.582	2.794
180	0.1147	0.115	0.1521	0.1140	0.0489	0.0323	0.0221	0.0249	0.0139	0.0181	0.0299	13.556	32.063	13.294	13.472	4.270	2.826	1.928	2.174	1.211	1.582	2.616
195	0.1179	0.120	-.0167	0.0761	0.0350	0.0165	0.0340	0.0201	0.0217	0.0420	0.0271	13.444	32.381	-1.412	8.679	2.950	1.391	2.864	1.691	1.832	3.544	2.286
AVG.	0.0987	0.082	0.1105	0.0932	0.0308	0.0317	0.0260	0.0290	0.0243	0.0184	0.0282	13.346	25.568	10.851	12.546	2.945	3.141	2.683	2.819	2.339	1.733	2.775

TEST No.2, RUN No.3
DATE: AUGUST 18 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

PRESSURE HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	22.38	17.96	16.94	16.74	13.37	9.81	4.71	3.18	1.14	0.00
30	13.91	12.35	12.05	11.84	9.30	5.22	2.93	2.16	1.14	0.00
45	14.47	12.56	12.15	11.85	7.26	6.24	3.69	2.67	1.14	0.00
60	14.98	12.76	12.15	11.84	9.81	6.24	3.69	2.67	1.14	0.00
75	13.57	11.34	10.83	10.32	6.75	5.22	3.39	2.67	1.14	0.00
90	17.14	14.19	12.97	12.56	12.36	6.75	3.69	2.67	1.14	0.00
105	14.08	11.85	11.13	10.32	7.77	5.22	3.69	3.18	1.14	0.00
120	12.96	10.93	10.32	10.01	7.26	5.73	4.71	3.18	1.14	0.00
135	18.56	15.92	15.01	13.37	9.30	7.26	3.18	2.37	1.14	0.00
150	21.14	17.96	16.94	16.43	12.87	8.79	4.20	3.18	1.14	0.00
165	16.54	13.88	12.97	12.35	9.30	5.73	4.20	2.67	1.14	0.00
180	16.08	13.37	12.36	11.64	7.26	4.71	2.67	1.96	1.14	0.00
195	13.61	10.83	9.81	10.32	7.26	6.03	3.18	2.67	1.45	0.00
AVG.	16.12	13.55	12.74	12.28	9.22	6.38	3.69	2.71	1.16	0.00

VELOCITY HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	1.01	1.11	1.11	0.44	0.44	0.44	0.44	0.44	0.44	0.44
30	1.13	0.69	0.69	0.27	0.27	0.27	0.27	0.27	0.27	0.27
45	1.16	0.71	0.71	0.28	0.28	0.28	0.28	0.28	0.28	0.28
60	1.15	0.70	0.70	0.28	0.28	0.28	0.28	0.28	0.28	0.28
75	0.99	0.68	0.68	0.24	0.24	0.24	0.24	0.24	0.24	0.24
90	1.23	0.75	0.75	0.30	0.30	0.30	0.30	0.30	0.30	0.30
105	1.01	0.62	0.62	0.24	0.24	0.24	0.24	0.24	0.24	0.24
120	0.96	0.58	0.58	0.23	0.23	0.23	0.23	0.23	0.23	0.23
135	1.35	0.83	0.83	0.33	0.33	0.33	0.33	0.33	0.33	0.33
150	1.63	1.00	1.00	0.39	0.39	0.39	0.39	0.39	0.39	0.39
165	1.22	0.74	0.74	0.29	0.29	0.29	0.29	0.29	0.29	0.29
180	1.07	0.66	0.66	0.26	0.26	0.26	0.26	0.26	0.26	0.26
195	1.03	0.63	0.63	0.25	0.25	0.25	0.25	0.25	0.25	0.25
AVG.	1.21	0.74	0.74	0.29	0.29	0.29	0.29	0.29	0.29	0.29

GRAVITATIONAL HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
30	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
45	0.00	0.61	0.61	0.60	0.71	0.66	1.03	0.84	0.88	1.77
60	0.00	0.61	0.61	0.60	0.71	0.66	1.03	0.84	0.88	1.77
75	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
90	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
105	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87
120	0.00	0.61	0.61	0.60	0.71	0.66	1.03	0.84	0.88	1.77
135	0.00	0.61	0.61	0.60	0.71	0.66	1.03	0.84	0.88	1.77
150	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.80
165	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.80
180	0.00	0.68	0.68	0.67	0.78	0.73	1.10	0.91	0.95	1.84
195	0.00	0.76	0.76	0.75	0.86	0.81	1.18	0.99	1.03	1.92
AVG.	0.00	0.65	0.65	0.64	0.75	0.70	1.07	0.88	0.92	1.81

TOTAL DYNAMIC HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	23.39	19.63	18.61	17.73	14.47	10.86	6.13	4.41	2.41	2.16
30	15.04	13.60	13.30	12.66	10.23	6.10	4.18	3.22	2.24	1.99
45	15.63	13.88	13.47	12.73	8.25	7.18	5.00	3.79	2.30	2.05
60	16.13	14.07	13.46	12.72	10.80	7.18	5.00	3.79	2.30	2.05
75	14.56	12.85	12.14	11.26	7.80	6.22	4.76	3.85	2.36	2.11
90	18.37	15.65	14.43	13.56	13.47	7.81	5.12	3.91	2.42	2.17
105	15.09	13.18	12.46	11.26	8.82	6.22	5.06	4.36	2.36	2.11
120	13.92	12.12	11.51	10.84	8.20	6.62	5.97	4.25	2.25	2.00
135	19.91	17.36	16.45	14.30	10.34	8.25	4.54	3.54	2.35	2.10
150	22.77	19.60	18.58	17.45	14.00	9.87	5.65	4.44	2.44	2.19
165	17.76	15.26	14.35	13.27	10.33	6.71	5.55	3.83	2.34	2.09
180	17.15	14.71	13.70	12.57	8.30	5.70	4.03	3.13	2.35	2.10
195	14.64	12.22	11.20	11.32	8.37	7.09	4.61	3.91	2.73	2.17
AVG.	17.34	14.93	14.13	13.21	10.26	7.37	5.05	3.88	2.37	2.10

TEST No.2, RUN No.6
DATE: AUGUST 10, & 11 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP															PEAT SLURRY PIPELINE											
TIME	RPM	DEPTH OF SUBMISSION (ft.)	(m)	DISCHARGE PRESSURE (ft.)	(m)	FLOW RATE GPM	m^3PM	POWER DEMAND HP.	Kw	ENERGY DEMAND Kwh	BRAKE HORSEPOWER HP	Kw	HYDRAULIC HORSEPOWER HP	Kw	Eff. %	TOTAL FLOW GAL	m^3	VELOCITY ft./s	m/s	TEMP °C	SOLIDS CONTENT %	ASH CONTENT %	VISCOSITY cps	SPECIFIC GRAVITY	KINEMATIC VISCOSITY ft²/s	m²/s	REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
---	----	-.---	-.--	---.-	--.--	----.	----.--	---.--	---.--	--.--	---.--	---.--	---.--	---.--	---.--	------.	---.--	--.--	-.--	--.-	-.--	--.--	---.-	-.---	-.-------	-.--------	-------.	-------.
15	1035	2.625	0.80	143.1	43.63	2010.	7.61	232.00	173.00	43.25	215.76	160.89	72.80	54.29	33.74	30150.	114.15	6.30	1.92	18.9	1.54	22.90	11.5	1.017	0.0001217	0.00001131	49240.	52306.
30	1034	2.625	0.80	126.4	38.54	2010.	7.61	236.29	176.20	44.05	219.75	163.87	64.30	47.95	29.26	30150.	114.15	6.30	1.92	18.9	2.90	30.42	47.0	1.028	0.0004921	0.00004572	12179.	12937.
45	1031	2.625	0.80	126.4	38.53	2010.	7.61	240.31	179.20	44.00	223.49	166.66	64.29	47.94	28.77	30150.	114.15	6.30	1.92	19.0	2.31	21.27	17.0	1.021	0.0001792	0.00001665	33441.	35523.
60	1032	2.657	0.81	124.8	38.05	1979.	7.49	236.56	176.40	44.10	219.99	164.05	62.49	46.60	28.41	29685.	112.35	6.20	1.89	18.6	3.32	34.17	36.0	1.030	0.0003762	0.00003495	15602.	16650.
75	1020	2.657	0.81	113.1	34.48	1947.	7.37	229.58	171.20	42.00	213.52	159.22	55.72	41.55	26.10	29205.	110.55	6.10	1.86	18.4	4.07	30.18	52.0	1.032	0.0005424	0.00005039	10785.	11371.
90	1025	2.709	0.83	123.3	37.57	2041.	7.73	238.70	178.00	44.50	221.99	165.54	63.67	47.48	28.68	30615.	115.95	6.40	1.95	18.9	4.46	27.74	38.0	1.027	0.0003983	0.00003700	15203.	16235.
105	1024	2.709	0.83	126.6	38.58	2010.	7.61	238.84	178.10	44.53	222.11	165.63	64.37	48.00	28.98	30150.	114.15	6.30	1.92	18.9	3.40	28.54	46.0	1.020	0.0004854	0.00004510	12346.	13115.
120	1009	2.709	0.83	124.9	38.08	2010.	7.61	238.97	178.20	44.55	222.25	165.73	63.54	47.38	28.59	30150.	114.15	6.30	1.92	18.7	3.49	21.27	35.5	1.026	0.0003724	0.00003460	16092.	17094.
135	994	3.010	0.92	122.5	37.34	1916.	7.25	217.65	162.30	40.58	202.41	150.94	59.35	44.26	29.32	28740.	108.75	6.00	1.83	17.9	3.14	23.42	45.0	1.026	0.0004721	0.00004386	12100.	12853.
150	965	3.010	0.92	106.7	32.53	1822.	6.90	181.31	135.20	33.80	168.62	125.74	49.22	36.70	29.19	27330.	103.50	5.70	1.74	18.4	1.05	24.73	7.5	1.015	0.0000795	0.00000739	68209.	72540.
165	1040	2.625	0.80	134.8	41.08	2041.	7.73	247.69	184.70	46.10	230.35	171.77	69.63	51.92	30.23	30615.	115.95	6.40	1.95	16.2	2.73	35.17	48.0	1.021	0.0005060	0.00004701	12829.	12777.
180	1046	2.821	0.86	130.0	39.61	1916.	7.25	253.10	188.80	47.20	235.46	175.58	62.96	46.95	26.74	28740.	108.75	6.00	1.83	16.6	2.24	30.12	20.0	1.019	0.0002113	0.00001963	27039.	28722.
AVG.	1023	2.753	0.84	125.2	38.17	1976.	7.48	232.59	173.44	43.36	216.31	161.30	62.70	46.75	29.00	29640.	112.20	6.19	1.89	18.3	2.91	26.04	33.8	1.024	0.0003550	0.00003299	23401.	24850.

1000 rpm, 0.03 inch clearance
Pipeline length 429.6 m

TEST No.2, RUN No.6
DATE: AUGUST 10, & 11 1984

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

FRICTION FACTOR (UNITLESS) HEAD LOSS m/100m

	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
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15	0.1737	5.073	0.0726	0.1352	0.0100	0.0263	0.0262	0.0261	0.0235	0.0244	0.0239	15.222	1040.571	4.786	11.049	1.220	1.707	1.697	1.691	1.522	1.502	1.547
30	0.1351	4.387	0.0744	0.1094	0.0156	0.0436	0.0242	0.0186	0.0235	0.0244	0.0250	11.833	898.159	4.024	9.505	1.010	2.026	1.570	1.200	1.522	1.502	1.674
45	0.1471	4.275	0.0563	0.1133	0.0219	0.0299	0.0242	0.0339	0.0259	0.0244	0.0262	12.009	883.492	3.647	9.925	1.420	1.935	1.570	2.190	1.677	1.502	1.699
60	0.1734	4.315	0.0543	0.1307	0.0226	0.0274	0.0209	0.0269	0.0267	0.0252	0.0263	14.722	864.127	3.412	11.096	1.420	1.717	1.813	1.691	1.677	1.502	1.649
75	0.0805	4.170	0.0561	0.0734	0.0103	0.0202	0.0279	0.0270	0.0250	0.0260	0.0250	7.270	888.009	3.412	6.030	1.110	1.717	1.697	1.691	1.522	1.502	1.522
90	0.0810	4.144	0.0546	0.0685	0.0242	0.0257	0.0289	0.0209	0.0204	0.0237	0.0254	7.309	883.492	3.647	6.109	1.620	1.717	1.920	1.932	1.366	1.502	1.699
105	0.1154	4.304	0.0545	0.0913	0.0100	0.0265	0.0333	0.0261	0.0235	0.0244	0.0255	10.111	906.032	3.529	8.000	1.220	1.717	2.159	1.691	1.522	1.502	1.649
120	0.1807	4.149	0.0563	0.1341	0.0171	0.0317	0.0200	0.0290	0.0235	0.0244	0.0255	15.033	857.460	3.647	11.925	1.110	2.054	1.813	1.932	1.522	1.502	1.649
135	0.1550	4.619	0.0540	0.1181	0.0155	0.0310	0.0300	0.0207	0.0259	0.0269	0.0259	12.333	867.302	3.176	9.396	0.910	1.826	1.813	1.691	1.522	1.502	1.522
150	0.0170	4.670	0.0553	0.0252	0.0210	0.0304	0.0295	0.0227	0.0196	0.0059	0.0262	1.270	792.698	2.941	1.811	1.120	2.043	1.570	1.200	1.040	0.316	1.394
165	0.1430	4.433	0.0722	0.1140	0.0242	0.0307	0.0209	0.0209	0.0251	0.0237	0.0273	13.000	945.079	4.024	10.377	1.620	2.054	1.920	1.932	1.677	1.502	1.827
180	0.1249	4.964	0.0560	0.0901	0.0311	0.0290	0.0200	0.0456	0.0203	0.0056	0.0209	9.944	932.063	3.294	7.811	1.030	1.707	1.697	2.601	1.196	0.316	1.699
AVG.	0.1281	4.459	0.0597	0.1012	0.0200	0.0307	0.0283	0.0287	0.0236	0.0216	0.0260	10.906	889.947	3.755	8.667	1.301	1.910	1.771	1.796	1.400	1.371	1.620

TEST No.2, RUN No.6
DATE: AUGUST 10, & 11 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

TIME	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
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15	43.63	40.49	7.46	7.36	6.83	4.51	2.67	2.16	1.14	0.00	0.79	0.48	0.48	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87	44.42	41.68	8.65	8.25	7.83	5.46	3.99	3.29	2.31	2.06
30	38.54	36.01	7.97	7.87	6.75	4.20	2.47	2.16	1.14	0.00	0.80	0.49	0.49	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87	39.34	37.21	9.17	8.76	7.75	5.15	3.79	3.29	2.31	2.06
45	38.53	35.80	7.97	7.97	6.44	4.71	2.98	2.26	1.14	0.00	0.79	0.49	0.49	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87	39.32	37.00	9.17	8.86	7.44	5.66	4.30	3.39	2.31	2.06
60	38.05	34.99	7.77	7.77	6.24	4.71	2.77	2.26	1.14	0.00	0.78	0.47	0.47	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.72	0.72	0.71	0.82	0.77	1.14	0.95	0.99	1.88	38.83	36.18	8.96	8.67	7.25	5.67	4.10	3.40	2.32	2.07
75	34.48	32.74	7.26	7.26	6.04	4.51	2.67	2.16	1.14	0.00	0.75	0.46	0.46	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.00	0.72	0.72	0.71	0.82	0.77	1.14	0.95	0.99	1.88	35.23	33.92	8.44	8.15	7.04	5.46	3.99	3.29	2.31	2.06
90	37.57	35.80	7.97	7.97	6.24	4.71	2.67	2.06	1.14	0.00	0.82	0.50	0.50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.76	0.76	0.75	0.86	0.81	1.18	0.99	1.03	1.92	38.39	37.06	9.23	8.92	7.30	5.72	4.05	3.25	2.37	2.12
105	38.58	36.31	7.77	7.77	6.44	4.91	2.67	2.16	1.14	0.00	0.79	0.48	0.48	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.76	0.76	0.75	0.86	0.81	1.18	0.99	1.03	1.92	39.37	37.55	9.01	8.71	7.49	5.91	4.04	3.34	2.36	2.11
120	38.00	34.78	7.77	7.77	6.55	4.71	2.77	2.16	1.14	0.00	0.80	0.49	0.49	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.76	0.76	0.75	0.86	0.81	1.18	0.99	1.03	1.92	38.80	36.03	9.02	8.71	7.60	5.71	4.14	3.34	2.36	2.11
135	37.34	34.58	7.26	7.26	6.24	4.61	2.67	2.16	1.14	0.00	0.73	0.44	0.44	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.00	0.83	0.83	0.82	0.93	0.88	1.25	1.06	1.10	1.99	38.07	35.85	8.53	8.26	7.35	5.67	4.10	3.40	2.42	2.17
150	32.53	31.72	6.75	6.75	5.52	3.69	1.96	1.65	0.94	0.00	0.65	0.40	0.40	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.00	0.83	0.83	0.82	0.93	0.88	1.25	1.06	1.10	1.99	33.18	32.95	7.98	7.73	6.61	4.73	3.37	2.87	2.20	2.15
165	41.08	38.35	8.58	8.48	6.75	4.91	2.87	2.26	1.14	0.00	0.82	0.50	0.50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87	41.90	39.56	9.79	9.38	7.76	5.87	4.20	3.40	2.32	2.07
180	39.61	37.33	7.97	7.97	6.03	4.51	2.67	1.75	0.94	0.00	0.72	0.44	0.44	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.00	0.77	0.77	0.76	0.87	0.82	1.19	1.00	1.04	1.93	40.33	38.54	9.18	8.90	7.07	5.50	4.03	2.92	2.15	2.10
AVG.	38.17	35.74	7.71	7.68	6.27	4.56	2.65	2.10	1.11	0.00	0.77	0.47	0.47	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.75	0.75	0.74	0.85	0.80	1.17	0.98	1.02	1.91	38.94	36.96	8.93	8.61	7.31	5.54	4.01	3.27	2.31	2.10

TEST No.2, RUN No.7
DATE: AUGUST 11 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP																				PEAT SLURRY PIPELINE						
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft^2/s	m^2/s	12" PIPELINE	RUBBER HOSE
15	1045	3.051	0.93	141.2	43.04	1696.	6.42	254.79	190.00	47.50	236.96	176.70	60.59	45.18	25.57	25440.	96.30	5.30	1.62	16.4	2.37	24.62	35.5	1.017	0.0003750	0.00003491	13459.	14297.
30	1043	3.010	0.92	140.5	42.84	1654.	6.26	247.28	184.40	46.10	229.97	171.49	58.80	43.85	25.57	24810.	93.90	5.20	1.58	16.2	2.82	26.26	41.0	1.024	0.0004310	0.00004004	11444.	12156.
45	1043	3.182	0.97	141.7	43.19	1654.	6.26	246.35	183.70	45.93	229.10	170.84	59.29	44.21	25.88	24810.	93.90	5.20	1.58	16.9	2.96	24.61	38.0	1.020	0.0004009	0.00003725	12299.	13065.
60	1055	3.182	0.97	140.7	42.89	1759.	6.66	243.66	181.70	45.43	226.61	168.98	62.63	46.70	27.64	26385.	99.90	5.50	1.68	17.7	2.36	22.20	23.5	1.020	0.0002480	0.00002304	21147.	22463.
75	1044	2.953	0.90	145.8	44.44	1654.	6.26	243.00	181.00	45.43	226.73	169.07	60.99	45.48	26.90	24810.	93.90	5.20	1.58	17.6	2.03	25.27	16.0	1.015	0.0001696	0.00001576	29067.	30877.
90	1044	3.010	0.92	145.9	44.46	1591.	6.02	243.66	181.70	45.43	226.61	168.98	58.68	43.76	25.90	23865.	90.30	5.00	1.52	18.3	1.79	20.15	15.0	1.015	0.0001591	0.00001478	29827.	31684.
105	1043	3.010	0.92	144.9	44.16	1654.	6.26	255.46	190.50	47.63	237.59	177.17	60.61	45.20	25.51	24810.	93.90	5.20	1.58	17.0	2.11	27.82	18.0	1.021	0.0001898	0.00001763	25990.	27600.
120	1041	2.986	0.91	145.5	44.36	1591.	6.02	240.76	185.50	46.30	231.35	172.52	58.55	43.66	25.31	23865.	90.30	5.00	1.52	17.3	3.09	24.42	35.5	1.024	0.0003732	0.00003467	12715.	13506.
135	1043	2.953	0.90	140.8	42.92	1591.	6.02	246.35	183.70	45.93	229.10	170.84	56.64	42.24	24.72	23865.	90.30	5.00	1.52	17.4	3.15	26.27	41.5	1.026	0.0004354	0.00004045	10898.	11576.
150	1043	2.887	0.88	141.7	43.20	1654.	6.26	244.47	182.30	45.58	227.36	169.54	59.30	44.22	26.08	24810.	93.90	5.20	1.58	17.3	2.94	22.12	26.0	1.021	0.0002741	0.00002547	17993.	19113.
165	1042	2.887	0.88	135.7	41.37	1591.	6.02	243.40	181.50	45.38	226.36	168.80	54.61	40.72	24.12	23865.	90.30	5.00	1.52	18.3	2.46	26.15	21.0	1.019	0.0002218	0.00002061	21389.	22721.
180	1042	2.854	0.87	130.6	39.82	1529.	5.79	241.79	180.30	45.08	224.86	167.68	50.56	37.70	22.48	22935.	86.85	4.80	1.46	18.1	2.08	20.19	17.0	1.015	0.0001803	0.00001675	25279.	26853.
AVG.	1044	2.999	0.91	141.3	43.06	1635.	6.19	246.65	183.93	45.99	229.30	171.05	58.44	43.58	25.47	24523.	92.85	5.13	1.56	17.4	2.51	24.20	27.4	1.020	0.0002800	0.00002603	19259.	20450.

1000 rpm, 0.03 inch clearance
Pipeline length 429.6 m
(Valve 30% open approx.)

TEST No.2, RUN No.7
DATE: AUGUST 11 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR	12" PIPELINE						AVG. FRICT. FACTOR	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m	12" PIPELINE						AVG. HEAD LOSS m/100m
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE	BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4	RUBBER HOSE	BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE
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15	0.1719	7.545	0.0000	0.1160	0.0176	0.0276	0.0290	0.0314	0.0192	0.0343	0.0247	10.722	1110.159	0.000	7.283	0.810	1.272	1.339	1.449	0.805	1.502	1.139
30	0.1807	7.004	0.0563	0.1361	0.0139	0.0265	0.0332	0.0330	0.0237	0.0216	0.0240	10.722	1103.492	2.471	8.075	0.610	1.163	1.455	1.449	1.040	0.949	1.009
45	0.1807	7.952	0.0027	0.1234	0.0207	0.0240	0.0332	0.0330	0.0237	0.0216	0.0260	10.722	1113.016	0.110	7.321	0.910	1.054	1.455	1.449	1.040	0.949	1.139
60	0.1623	6.974	0.0071	0.1119	0.0103	0.0234	0.0270	0.0341	0.0147	0.0319	0.0230	10.009	1103.492	0.353	7.509	0.910	1.163	1.339	1.691	0.730	1.502	1.139
75	0.1700	0.106	0.0027	0.1221	0.0207	0.0315	0.0305	0.0305	0.0237	0.0216	0.0277	10.611	1145.714	0.110	7.245	0.910	1.300	1.339	1.691	1.040	0.949	1.214
90	0.1922	0.045	-.0029	0.1299	0.0224	0.0313	0.0350	0.0416	0.0256	0.0234	0.0299	10.556	1145.714	-0.110	7.132	0.910	1.272	1.455	1.691	1.040	0.949	1.214
105	0.1807	0.116	0.0027	0.1234	0.0230	0.0290	0.0332	0.0330	0.0202	0.0361	0.0277	10.722	1135.073	0.110	7.321	1.010	1.272	1.455	1.449	0.805	1.502	1.214
120	0.1932	0.020	-.0029	0.1306	0.0224	0.0316	0.0350	0.0351	0.0290	0.0234	0.0300	10.611	1142.540	-0.110	7.178	0.910	1.203	1.455	1.425	1.211	0.949	1.217
135	0.1932	0.519	0.0000	0.1313	0.0172	0.0343	0.0350	0.0357	0.0210	0.0390	0.0287	10.611	1103.492	0.000	7.280	0.700	1.391	1.455	1.449	0.805	1.502	1.164
150	0.1807	7.004	0.0000	0.1228	0.0105	0.0315	0.0361	0.0325	0.0241	0.0361	0.0283	10.722	1103.492	0.000	7.203	0.810	1.300	1.502	1.425	1.056	1.502	1.242
165	0.1943	0.171	-.0058	0.1306	0.0224	0.0286	0.0330	0.0357	0.0210	0.0390	0.0281	10.667	1050.413	-0.235	7.170	0.910	1.163	1.339	1.449	0.805	1.502	1.139
180	0.2073	0.585	-.0094	0.1305	0.0107	0.0310	0.0300	0.0307	0.0195	0.0422	0.0270	10.500	1026.032	-0.353	7.019	0.400	1.163	1.455	1.449	0.730	1.502	1.012
AVG.	0.1847	0.123	0.0042	0.1265	0.0190	0.0292	0.0335	0.0352	0.0223	0.0309	0.0272	10.671	1107.619	0.196	7.311	0.817	1.246	1.427	1.506	0.952	1.310	1.160

TEST No.2, RUN No.7
DATE: AUGUST 11 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
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15	43.04	40.49	5.52	5.73	4.81	3.69	2.16	1.75	1.14	0.00	0.56	0.34	0.34	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.00	0.84	0.84	0.83	0.94	0.89	1.26	1.07	1.11	2.00	43.60	41.67	6.70	6.70	5.89	4.72	3.56	2.96	2.39	2.14
30	42.84	40.29	5.53	5.53	4.81	3.79	2.16	1.75	1.04	0.00	0.54	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.83	0.83	0.82	0.93	0.88	1.25	1.06	1.10	1.99	43.38	41.45	6.69	6.48	5.87	4.80	3.54	2.94	2.27	2.12
45	43.19	40.59	5.53	5.73	4.71	3.79	2.16	1.75	1.04	0.00	0.54	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.88	0.88	0.87	0.98	0.93	1.30	1.11	1.15	2.04	43.73	41.80	6.74	6.73	5.82	4.85	3.59	2.99	2.32	2.17
60	42.89	40.29	5.53	5.73	4.71	3.69	2.16	1.65	1.14	0.00	0.61	0.37	0.37	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.00	0.88	0.88	0.87	0.98	0.93	1.30	1.11	1.15	2.04	43.50	41.54	6.78	6.75	5.84	4.77	3.61	2.91	2.44	2.19
75	44.44	41.92	5.83	6.03	5.01	3.79	2.26	1.75	1.04	0.00	0.53	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.81	0.81	0.80	0.91	0.86	1.23	1.04	1.08	1.97	44.97	43.06	6.97	6.96	6.05	4.78	3.62	2.92	2.25	2.10
90	44.46	41.92	5.83	6.03	5.01	3.89	2.26	1.75	1.04	0.00	0.49	0.30	0.30	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.83	0.83	0.82	0.93	0.88	1.25	1.06	1.10	1.99	44.95	43.05	6.96	6.97	6.06	4.89	3.63	2.93	2.26	2.11
105	44.16	41.61	5.83	6.03	4.91	3.79	2.16	1.75	1.14	0.00	0.54	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.83	0.83	0.82	0.93	0.88	1.25	1.06	1.10	1.99	44.70	42.77	6.99	6.98	5.97	4.80	3.54	2.94	2.37	2.12
120	44.36	41.82	5.83	6.04	5.02	3.89	2.26	1.86	1.04	0.00	0.50	0.31	0.31	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.82	0.82	0.81	0.92	0.87	1.24	1.05	1.09	1.98	44.86	42.95	6.96	6.97	6.06	4.88	3.62	3.03	2.25	2.10
135	42.92	40.39	5.63	5.83	5.82	3.79	2.16	1.75	1.14	0.00	0.50	0.31	0.31	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.81	0.81	0.80	0.91	0.86	1.23	1.04	1.08	1.97	43.42	41.51	6.75	6.75	6.85	4.77	3.51	2.91	2.34	2.09
150	43.20	40.69	5.93	6.14	5.22	4.00	2.26	1.86	1.14	0.00	0.54	0.33	0.33	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.79	0.79	0.78	0.89	0.84	1.21	1.02	1.06	1.95	43.74	41.81	7.05	7.05	6.24	4.97	3.60	3.01	2.33	2.08
165	41.37	38.86	5.52	5.73	4.71	3.69	2.16	1.75	1.14	0.00	0.50	0.30	0.30	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.79	0.79	0.78	0.89	0.84	1.21	1.02	1.06	1.95	41.87	39.95	6.61	6.63	5.72	4.65	3.49	2.89	2.32	2.07
180	39.82	37.33	5.81	5.22	4.71	3.69	2.06	1.65	1.14	0.00	0.46	0.28	0.28	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.00	0.78	0.78	0.77	0.88	0.83	1.20	1.01	1.05	1.94	40.28	38.39	6.87	6.10	5.70	4.63	3.37	2.77	2.30	2.05
AVG.	43.06	40.52	5.63	5.81	4.89	3.79	2.19	1.75	1.10	0.00	0.53	0.32	0.32	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.00	0.82	0.82	0.81	0.92	0.87	1.24	1.05	1.09	1.98	43.58	41.66	6.77	6.76	5.94	4.79	3.56	2.93	2.32	2.11

TEST No.2, RUN No.8 (WITH ELBOW)
DATE: AUGUST 12 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP														PEAT SLURRY PIPELINE												
TIME	RPM	DEPTH OF SUBMISSION (ft.)	(m)	DISCHARGE PRESSURE (ft.)	(m)	FLOW RATE GPM	m^3PM	POWER DEMAND HP.	Kw	ENERGY DEMAND Kwh	BRAKE HORSEPOWER HP	Kw	HYDRAULIC HORSEPOWER HP	Kw	Eff. %	TOTAL FLOW GAL	m^3	VELOCITY ft./s	m/s	TEMP °C	SOLIDS CONTENT %	ASH CONTENT %	VISCOSITY cps	SPECIFIC GRAVITY	KINEMATIC VISCOSITY ft²/s	m²/s	REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
10	1045	2.190	0.67	72.4	22.08	3730.	14.15	260.83	194.50	48.63	242.50	180.89	68.50	51.08	28.24	37300.	141.50	11.70	3.57	16.6	0.47	30.77	4.2	1.000	0.0000449	0.00000417	248472.	263940.
20	1043	2.190	0.67	67.4	20.54	3601.	13.63	260.29	194.10	48.53	242.07	180.51	61.38	45.77	25.36	36010.	136.30	11.30	3.44	16.4	0.63	25.60	4.5	1.004	0.0000482	0.00000448	222576.	236432.
30	1042	2.953	0.90	54.8	16.70	2837.	10.74	262.04	195.40	48.85	243.69	181.72	39.33	29.33	16.14	28370.	107.40	8.90	2.71	16.2	0.72	25.90	4.3	1.013	0.0000459	0.00000426	184595.	196087.
40	1042	2.953	0.90	48.1	14.67	2429.	9.19	259.49	193.50	48.38	241.33	179.96	29.56	22.04	12.25	24290.	91.90	7.60	2.32	18.1	1.07	28.30	20.0	1.015	0.0002120	0.00001970	34145.	36270.
AVG.	1043	2.576	0.79	60.7	18.50	3151.	11.93	260.66	194.38	48.60	242.42	180.77	49.69	37.06	20.50	31513.	119.30	9.88	3.01	16.7	0.84	27.72	7.4	1.009	0.0000783	0.00000727	185410.	196953.

1000 rpm, 0.03 inch clearance
Pipeline length 264 m

TEST No.2, RUN No.8 (WITH ELBOW)
DATE: AUGUST 12 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)												HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
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10	0.0655	0.054	0.0536	0.0572	0.0291	0.0400	0.0154	0.0340	0.1339	0.0323	0.0316	19.833	30.730	12.000	17.321	6.520	8.968	3.451	7.626	30.000	7.230	7.072
20	0.0589	0.049	0.0639	0.0551	0.0279	0.0412	0.0200	0.0349	0.1200	0.0302	0.0319	16.556	32.301	13.294	15.509	5.810	8.563	4.155	7.264	25.116	6.286	6.637
30	0.0996	0.118	0.0720	0.0847	0.0252	0.0400	0.0211	0.0393	0.1586	0.0487	0.0346	17.389	40.571	9.294	14.792	3.250	6.296	2.723	5.072	20.465	6.286	4.463
40	0.1073	0.032	0.0796	0.0917	0.0473	0.0666	0.0112	0.0418	0.1910	0.0252	0.0458	13.722	9.524	7.529	11.736	4.470	6.296	1.856	3.957	18.140	2.381	4.331
AVG.	0.0828	0.063	0.0673	0.0722	0.0324	0.0492	0.0169	0.0375	0.1513	0.0341	0.0360	16.875	32.302	10.529	14.840	5.013	7.531	2.046	5.980	23.430	5.540	5.626

TEST No.2, RUN No.8 (WITH ELBOW)
DATE: AUGUST 12 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
10	22.00	18.90	17.76	17.76	11.13	6.75	4.91	2.98	1.65	0.00	2.71	1.66	1.66	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.00	0.50	0.50	0.57	0.60	0.63	1.00	0.81	0.85	1.74	24.79	21.22	20.00	18.98	12.46	8.03	6.56	4.44	3.15	2.39
20	20.54	17.96	16.94	16.74	10.82	6.64	4.50	2.67	1.55	0.00	2.51	1.53	1.53	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.00	0.50	0.50	0.57	0.60	0.63	1.00	0.81	0.85	1.74	23.05	20.07	19.05	17.92	12.11	7.08	6.11	4.09	3.01	2.35
30	16.70	13.37	11.84	11.64	8.28	5.22	3.69	2.47	1.55	0.00	1.57	0.96	0.96	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.01	0.01	0.00	0.91	0.86	1.23	1.04	1.08	1.97	18.27	15.14	13.61	12.02	9.37	6.46	5.38	3.09	3.01	2.35
40	14.47	11.84	11.54	11.33	6.75	3.69	2.87	1.96	1.14	0.00	1.15	0.70	0.70	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.01	0.01	0.00	0.91	0.86	1.23	1.04	1.08	1.97	15.82	13.35	13.05	12.41	7.94	4.83	4.38	3.28	2.50	2.25
AVG.	18.58	15.54	14.52	14.37	9.25	5.50	3.99	2.52	1.47	0.00	1.99	1.21	1.21	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.00	0.70	0.70	0.69	0.80	0.75	1.12	0.93	0.97	1.86	20.48	17.45	16.43	15.53	10.52	6.80	5.59	3.93	2.92	2.34

TEST No.2, RUN No.8 (WITHOUT ELBOW)
DATE: AUGUST 12 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)										HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE					AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE					AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&DIS.	
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10	0.2013	5.612	0.0124	0.1397	0.0212	0.0416	0.0186	0.0426	0.0883	0.0298	15.500	1019.365	0.706	10.755	1.210	2.360	1.056	2.427	5.031	1.694
20	0.2074	5.473	0.0107	0.1434	0.0222	0.0353	0.0192	0.0441	0.0914	0.0291	15.444	961.270	0.588	10.679	1.220	1.943	1.056	2.427	5.031	1.684
30	0.1709	5.470	0.0124	0.1245	0.0248	0.0345	0.0227	0.0426	0.0883	0.0305	13.778	993.651	0.706	9.585	1.410	1.964	1.291	2.427	5.031	1.740
40	0.1591	5.309	0.0140	0.1114	0.0241	0.0402	0.0179	0.0495	0.0646	0.0304	12.667	996.825	0.824	8.868	1.420	2.360	1.056	2.913	3.804	1.709
50	0.0909	5.505	0.0124	0.0647	0.0248	0.0419	0.0181	0.0426	0.0660	0.0305	7.000	1000.000	0.706	4.901	1.410	2.309	1.033	2.427	3.804	1.740
60	0.1321	5.527	0.0128	0.0927	0.0238	0.0357	0.0234	0.0529	0.0691	0.0308	9.833	970.794	0.706	6.906	1.310	1.964	1.291	2.913	3.804	1.694
70	0.1652	5.327	0.0124	0.1152	0.0267	0.0380	0.0140	0.0511	0.0660	0.0305	12.722	967.619	0.706	8.860	1.520	2.166	0.790	2.913	3.804	1.740
80	0.1685	5.154	0.0160	0.1128	0.0275	0.0334	0.0136	0.0495	0.0646	0.0296	12.778	967.619	0.941	8.901	1.620	1.964	0.790	2.913	3.804	1.740
AVG.	0.1619	5.422	0.0129	0.1131	0.0244	0.0376	0.0184	0.0469	0.0750	0.0302	12.465	984.643	0.735	8.783	1.390	2.141	1.047	2.670	4.264	1.718

TEST No.1, RUN No.8 (WITHOUT ELBOW)
DATE: AUGUST 12 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP															PEAT SLURRY PIPELINE												
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s		
---	----	-.---	-.--	---.-	--.--	----.	----.--	---.--	---.--	--.--	---.--	---.--	--.--	--.--	--.--	------.	---.--	--.--	-.--	--.-	-.--	--.--	---.-	-.---	-.-------	-.--------	-------.	-------.
10	1037	2.362	0.72	131.1	39.97	1884.	7.13	249.03	185.70	46.43	231.59	172.70	62.49	46.60	26.98	18840.	71.30	5.90	1.80	19.5	0.70	24.80	4.0	1.009	0.0000512	0.00000476	109729.	116560.
20	1038	2.362	0.72	124.4	37.93	1853.	7.01	246.08	183.50	45.88	228.84	170.66	58.29	43.47	25.47	18530.	70.10	5.80	1.77	19.5	0.79	24.56	4.9	1.009	0.0000523	0.00000486	105690.	112278.
30	1038	2.657	0.81	128.1	39.04	1884.	7.13	235.89	175.90	43.98	219.38	163.59	61.03	45.51	27.82	18840.	71.30	5.90	1.80	19.5	0.66	20.61	4.3	1.011	0.0000457	0.00000425	122731.	130371.
40	1039	2.657	0.81	128.1	39.04	1916.	7.25	238.70	178.00	44.50	221.99	165.54	62.06	46.28	27.96	19160.	72.50	6.00	1.83	19.4	0.67	20.80	5.2	1.008	0.0000555	0.00000516	102874.	109278.
50	1040	2.986	0.91	125.1	38.12	1884.	7.13	240.71	179.50	44.88	223.87	166.94	59.60	44.44	26.62	18840.	71.30	5.90	1.80	19.3	0.91	25.29	6.4	1.012	0.0000680	0.00000632	82541.	87680.
60	1038	2.986	0.91	123.4	37.62	1853.	7.01	242.05	180.50	45.13	225.12	167.87	57.82	43.12	25.69	18530.	70.10	5.80	1.77	19.3	1.62	30.28	10.6	1.013	0.0001126	0.00001046	49054.	52108.
70	1039	3.346	1.02	125.5	38.24	1884.	7.13	237.49	177.10	44.28	220.87	164.70	59.78	44.58	27.07	18840.	71.30	5.90	1.80	19.1	1.43	29.26	8.2	1.016	0.0000869	0.00000807	64677.	68703.
80	1038	4.265	1.30	126.4	38.52	1916.	7.25	238.97	178.20	44.55	222.25	165.73	61.23	45.66	27.55	19160.	72.50	6.00	1.83	19.0	1.10	26.70	7.7	1.012	0.0000819	0.00000761	69749.	74091.
AVG.	1038	2.953	0.90	126.5	38.56	1884.	7.13	241.12	179.80	44.95	224.24	167.22	60.29	44.96	26.90	18843.	71.30	5.90	1.80	19.3	0.99	25.17	6.5	1.011	0.0000692	0.00000643	88419.	93924.

1000 rpm, 0.03 inch clearance
Pipeline length 250.2 m

TEST No.2, RUN No.8 (WITHOUT ELBOW)
DATE: AUGUST 12 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

PRESSURE HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	PDIS. (m)
10	39.97	36.82	4.71	4.91	3.59	2.47	1.65	1.34	0.00
20	37.93	34.78	4.50	4.71	3.38	2.47	1.65	1.34	0.00
30	39.04	36.11	4.81	5.01	3.49	2.57	1.65	1.34	0.00
40	39.04	36.31	4.91	5.12	3.59	2.47	1.65	1.24	0.00
50	38.12	36.31	4.81	5.01	3.49	2.36	1.55	1.24	0.00
60	37.62	35.29	4.71	4.91	3.49	2.57	1.65	1.24	0.00
70	38.24	35.29	4.81	5.01	3.38	2.36	1.65	1.24	0.00
80	38.52	35.29	4.81	5.01	3.28	2.36	1.65	1.24	0.00
AVG.	38.56	35.78	4.76	4.96	3.46	2.45	1.64	1.28	0.00

VELOCITY HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	PDIS. (m)
10	0.69	0.42	0.42	0.17	0.17	0.17	0.17	0.17	0.17
20	0.67	0.41	0.41	0.16	0.16	0.16	0.16	0.16	0.16
30	0.69	0.42	0.42	0.17	0.17	0.17	0.17	0.17	0.17
40	0.71	0.44	0.44	0.17	0.17	0.17	0.17	0.17	0.17
50	0.69	0.42	0.42	0.17	0.17	0.17	0.17	0.17	0.17
60	0.67	0.41	0.41	0.16	0.16	0.16	0.16	0.16	0.16
70	0.69	0.42	0.42	0.17	0.17	0.17	0.17	0.17	0.17
80	0.72	0.44	0.44	0.17	0.17	0.17	0.17	0.17	0.17
AVG.	0.69	0.42	0.42	0.17	0.17	0.17	0.17	0.17	0.17

GRAVITATIONAL HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	PDIS. (m)
10	0.00	0.63	0.63	0.62	0.73	0.68	1.05	0.86	1.79
20	0.00	0.63	0.63	0.62	0.73	0.68	1.05	0.86	1.79
30	0.00	0.72	0.72	0.71	0.82	0.77	1.14	0.95	1.88
40	0.00	0.72	0.72	0.71	0.82	0.77	1.14	0.95	1.88
50	0.00	0.82	0.82	0.81	0.92	0.87	1.24	1.05	1.98
60	0.00	0.82	0.82	0.81	0.92	0.87	1.24	1.05	1.98
70	0.00	0.93	0.93	0.92	1.03	0.98	1.35	1.16	2.09
80	0.00	1.21	1.21	1.20	1.31	1.26	1.63	1.44	2.37
AVG.	0.00	0.81	0.81	0.80	0.91	0.86	1.23	1.04	1.97

TOTAL DYNAMIC HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	PDIS. (m)
10	40.66	37.87	5.76	5.70	4.49	3.32	2.87	2.37	1.96
20	38.60	35.82	5.54	5.49	4.27	3.31	2.86	2.36	1.95
30	39.73	37.25	5.95	5.89	4.48	3.51	2.96	2.46	2.05
40	39.75	37.47	6.07	6.00	4.58	3.41	2.96	2.36	2.05
50	38.81	37.55	6.05	5.99	4.58	3.40	2.96	2.46	2.15
60	38.29	36.52	5.94	5.88	4.57	3.60	3.05	2.45	2.14
70	38.93	36.64	6.16	6.10	4.58	3.51	3.17	2.57	2.26
80	39.24	36.94	6.46	6.38	4.76	3.79	3.45	2.85	2.54
AVG.	39.25	37.01	5.99	5.93	4.54	3.48	3.04	2.49	2.14

SPECIAL RUN No.1
DATE: AUGUST 7 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

PEAT SLURRY PUMP — PEAT SLURRY PIPELINE

TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft^2/s	m^2/s	12" PIPELINE	RUBBER HOSE
15	791	1.476	0.45	41.6	12.69	2293.	8.68	112.83	84.14	21.04	103.47	77.16	24.15	18.01	23.34	34395.	130.20	7.20	2.19	10.8	1.24	22.22	10.8	1.015	0.0001145	0.00001064	59600.	63403.
30	791	1.476	0.45	40.6	12.38	2167.	8.20	111.57	83.20	20.80	102.31	76.29	22.26	16.60	21.76	32505.	123.00	6.80	2.07	10.7	1.05	20.20	22.5	1.016	0.0002304	0.00002215	27107.	28794.
45	791	1.476	0.45	38.3	11.66	1916.	7.25	110.29	82.24	20.56	101.13	75.41	18.53	13.82	18.33	28740.	108.75	6.00	1.83	10.7	1.03	10.30	8.5	1.009	0.0000906	0.00000842	62997.	66919.
60	792	1.640	0.50	40.1	12.23	2136.	8.08	108.86	81.18	20.30	99.83	74.44	21.67	16.16	21.71	32040.	121.28	6.70	2.04	19.3	2.19	30.27	11.5	1.019	0.0001215	0.00001129	52421.	55684.
75	792	1.640	0.50	36.8	11.23	1916.	7.25	113.49	84.63	21.16	104.08	77.61	17.85	13.31	17.15	28740.	108.75	6.00	1.83	10.3	3.93	31.27	40.0	1.036	0.0004156	0.00003861	13745.	14601.
90	791	2.034	0.62	35.5	10.83	1759.	6.66	111.80	83.37	20.84	102.52	76.45	15.81	11.79	15.42	26385.	99.90	5.50	1.68	10.5	4.10	42.05	48.5	1.022	0.0005100	0.00004746	10266.	10905.
105	789	2.034	0.62	42.3	12.89	2041.	7.73	115.56	86.17	21.54	105.97	79.02	21.83	16.28	20.60	30615.	115.95	6.40	1.95	10.4	2.96	43.05	23.0	1.032	0.0002399	0.00002229	25374.	26953.
120	788	2.034	0.62	40.6	12.36	2041.	7.73	114.35	85.27	21.32	104.85	78.19	20.95	15.62	19.98	30615.	115.95	6.40	1.95	10.5	3.47	42.12	41.5	1.026	0.0004354	0.00004045	13901.	14051.
AVG.	791	1.726	0.53	39.5	12.03	2034.	7.70	112.34	83.78	20.95	103.02	76.82	20.38	15.20	19.79	30504.	115.50	6.38	1.94	10.7	2.54	30.07	25.1	1.022	0.0002634	0.00002448	33907.	36182.

800 rpm, 0.03 inch clearance
Pipeline length 436.5 m

SPECIAL RUN No.1
DATE: AUGUST 7 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m									
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.0824	0.072	0.0616	0.0789	0.0209	0.0244	0.0214	0.0289	0.0311	0.0030	0.0256	9.396	19.365	7.027	8.884	2.440	2.054	1.001	2.440	2.624	0.316	2.159
30	0.0898	0.094	0.0621	0.0741	0.0311	0.0271	0.0225	0.0321	0.0320	0.0042	0.0276	9.860	22.540	6.324	7.545	2.340	2.043	1.697	2.415	2.469	0.316	2.001
45	0.1147	0.086	0.1501	0.1343	0.0155	0.0273	0.0420	0.0287	0.0311	0.0161	0.0280	9.120	16.190	11.946	10.689	0.918	1.609	2.517	1.691	1.832	0.949	1.649
60	0.1045	0.083	0.0743	0.0878	0.0194	0.0355	0.0297	0.0264	0.0272	0.0043	0.0267	10.336	19.365	7.351	8.683	1.420	2.598	2.171	1.932	1.900	0.316	1.954
75	0.1080	0.086	0.1440	0.1203	0.0136	0.0255	0.0400	0.0287	0.0311	0.0161	0.0267	0.650	16.190	11.459	10.210	0.800	1.500	2.402	1.691	1.832	0.949	1.572
90	0.1651	0.122	0.1410	0.1522	0.0081	0.0302	0.0402	0.0292	0.0369	-.0064	0.0281	11.874	19.365	9.514	10.210	0.480	1.500	2.398	1.449	1.832	-0.316	1.394
105	0.1745	0.122	0.0921	0.1209	0.0212	0.0257	0.0306	0.0325	0.0323	0.0047	0.0266	15.772	26.032	8.324	11.647	1.420	1.717	2.044	2.174	2.150	0.316	1.777
120	0.1515	0.121	0.0796	0.1116	0.0212	0.0257	0.0306	0.0325	0.0323	0.0047	0.0266	13.691	25.714	7.189	10.890	1.420	1.717	2.044	2.174	2.150	0.316	1.777
AVG.	0.1238	0.098	0.1007	0.1110	0.0199	0.0277	0.0333	0.0299	0.0319	0.0059	0.0270	10.089	20.595	8.642	9.645	1.394	1.842	2.133	1.996	2.112	0.395	1.795

SPECIAL RUN No.1
DATE: AUGUST 7 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	12.69	11.33	10.72	9.81	7.26	5.42	3.49	2.67	0.94	0.00	1.03	0.63	0.63	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.00	0.36	0.36	0.35	0.46	0.41	0.78	0.59	0.63	1.52	13.72	12.32	11.71	10.41	7.97	6.08	4.52	3.51	1.82	1.77
30	12.38	11.03	10.32	9.50	7.05	5.22	3.30	2.57	0.94	0.00	0.92	0.56	0.56	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	0.36	0.36	0.35	0.46	0.41	0.78	0.59	0.63	1.52	13.30	11.95	11.24	10.07	7.73	5.85	4.30	3.38	1.79	1.74
45	11.66	10.21	9.70	7.77	6.75	5.32	2.77	2.26	1.04	0.00	0.71	0.44	0.44	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.00	0.36	0.36	0.35	0.46	0.41	0.78	0.59	0.63	1.52	12.37	11.01	10.50	8.29	7.38	5.90	3.72	3.02	1.84	1.69
60	12.23	10.62	10.01	8.99	7.46	5.12	2.87	2.26	0.94	0.00	0.89	0.55	0.55	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	0.41	0.41	0.40	0.51	0.46	0.83	0.64	0.68	1.57	13.12	11.58	10.97	9.61	8.19	5.80	3.92	3.12	1.84	1.79
75	11.23	9.81	9.30	7.46	6.55	5.22	2.77	2.26	1.04	0.00	0.73	0.45	0.45	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.00	0.41	0.41	0.40	0.51	0.46	0.83	0.64	0.68	1.57	11.96	10.67	10.16	8.04	7.24	5.86	3.78	3.08	1.90	1.75
90	10.83	8.89	8.28	6.75	6.24	4.91	2.47	2.06	0.84	0.00	0.61	0.37	0.37	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.00	0.53	0.53	0.52	0.63	0.58	0.95	0.76	0.80	1.69	11.44	9.79	9.18	7.42	7.02	5.64	3.57	2.97	1.79	1.84
105	12.88	10.32	9.50	8.28	6.75	5.22	3.08	2.37	0.94	0.00	0.83	0.51	0.51	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.53	0.53	0.52	0.63	0.58	0.95	0.76	0.80	1.69	13.71	11.36	10.54	9.00	7.58	6.00	4.23	3.33	1.94	1.89
120	12.36	10.11	9.30	8.28	6.75	5.22	3.08	2.37	0.94	0.00	0.82	0.50	0.50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.53	0.53	0.52	0.63	0.58	0.95	0.76	0.80	1.69	13.18	11.14	10.33	9.00	7.58	6.00	4.23	3.33	1.94	1.89
AVG.	12.03	10.29	9.64	8.36	6.85	5.21	2.99	2.35	0.95	0.00	0.82	0.50	0.50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.44	0.44	0.43	0.54	0.49	0.86	0.67	0.71	1.60	12.85	11.23	10.58	8.99	7.59	5.89	4.04	3.22	1.86	1.80

SPECIAL RUN No.2
DATE: AUGUST 8 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP																PEAT SLURRY PIPELINE												
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
---	----	-.---	-.--	---.-	--.--	----.	----.--	---.--	---.--	--.--	---.--	---.--	---.--	---.--	---.--	------.	---.--	--.--	-.--	--.-	-.--	--.--	---.-	-.---	-.-------	-.--------	-------.	-------.
15	792	1.968	0.60	48.8	14.88	2523.	9.55	111.67	83.27	20.82	102.40	76.36	31.15	23.23	30.42	37845.	143.25	7.90	2.41	16.6	2.34	34.25	17.0	1.020	0.0001794	0.00001667	41934.	44544.
30	788	1.968	0.60	46.2	14.08	2429.	9.19	111.61	83.23	20.81	102.35	76.32	28.38	21.16	27.73	36435.	137.85	7.60	2.32	16.8	4.09	34.52	40.5	1.033	0.0005054	0.00004695	14330.	15222.
45	789	1.968	0.60	38.8	11.83	2136.	8.08	109.32	81.52	20.38	100.24	74.75	20.96	15.63	20.91	32040.	121.28	6.70	2.04	16.2	4.04	35.26	67.5	1.020	0.0007067	0.00006566	9810.	9571.
60	777	2.625	0.80	44.5	13.56	2136.	8.08	109.09	81.35	20.34	100.04	74.60	24.02	17.91	24.01	32040.	121.28	6.70	2.04	16.2	3.39	35.35	52.5	1.024	0.0005518	0.00005127	11539.	12257.
75	791	2.625	0.80	33.5	10.20	1591.	6.02	100.89	75.23	18.81	92.52	68.99	13.46	10.04	14.55	23865.	90.30	5.00	1.52	16.5	3.00	34.12	44.5	1.022	0.0004686	0.00004354	10124.	10754.
90	792	2.395	0.73	34.9	10.63	1979.	7.49	106.25	79.23	19.81	97.43	72.65	17.46	13.02	17.92	29685.	112.35	6.20	1.89	17.0	2.17	36.14	15.5	1.017	0.0001640	0.00001524	35962.	38201.
105	791	2.461	0.75	40.0	12.18	2041.	7.73	108.93	81.23	20.31	99.89	74.49	20.64	15.39	20.66	30615.	115.95	6.40	1.95	17.1	1.46	32.10	12.2	1.015	0.0001294	0.00001202	47848.	49977.
AVG.	789	2.287	0.70	41.0	12.48	2119.	8.02	108.25	80.72	20.18	99.27	74.02	22.30	16.63	22.31	31789.	120.30	6.64	2.02	16.6	2.95	34.54	36.6	1.023	0.0003843	0.00003571	24798.	26342.

800 rpm, 0.03 inch clearance
Pipeline length 436.5 m

SPECIAL RUN No.2
DATE: AUGUST 8 1984

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m									
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.1220	0.090	0.0304	0.0757	0.0260	0.0254	0.0235	0.0260	0.0211	0.0031	0.0236	16.046	32.063	5.297	10.449	2.650	2.590	2.402	2.657	2.150	0.316	2.414
30	0.1196	0.096	0.0406	0.0750	0.0250	0.0240	0.0291	0.0203	0.0177	0.0033	0.0242	15.302	20.009	5.109	9.701	2.440	2.272	2.740	2.601	1.677	0.316	2.206
45	0.1262	0.139	0.0465	0.0020	0.0334	0.0279	0.0007	0.0334	0.0200	0.0216	0.0243	12.403	32.301	4.595	0.114	2.440	2.043	0.635	2.440	1.522	1.502	1.777
60	0.1126	0.097	0.1301	0.1223	0.0264	0.0250	0.0376	0.0132	0.0200	0.0216	0.0260	11.141	22.540	12.065	12.096	1.930	1.026	2.740	0.966	1.522	1.502	1.904
75	0.2603	0.149	0.0304	0.1374	0.0399	0.0506	0.0270	0.0416	0.0141	0.0070	0.0343	14.295	19.365	2.100	7.545	1.620	2.054	1.097	1.691	0.575	0.316	1.394
90	0.1431	-0.032	0.0764	0.1062	0.0226	0.0105	0.0401	0.0269	0.0267	0.0151	0.0263	12.140	-6.349	6.406	9.012	1.420	1.163	2.517	1.691	1.677	0.949	1.649
105	0.1730	0.106	0.0490	0.1044	0.0365	0.0307	0.0093	0.0365	0.0274	0.0047	0.0266	15.630	22.540	4.432	9.431	2.440	2.054	0.624	2.440	1.032	0.316	1.777
AVG.	0.1510	0.093	0.0599	0.1005	0.0301	0.0209	0.0250	0.0294	0.0212	0.0110	0.0265	13.979	21.633	5.053	9.470	2.134	2.001	1.024	2.001	1.566	0.740	1.006

SPECIAL RUN No.2
DATE: AUGUST 8 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

TIME	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	14.88	12.35	11.34	10.83	8.07	5.73	3.28	2.37	0.94	0.00	1.25	0.76	0.76	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.00	0.51	0.51	0.50	0.61	0.56	0.93	0.74	0.78	1.67	16.13	13.62	12.61	11.63	8.98	6.59	4.51	3.41	2.02	1.97
30	14.08	11.74	10.83	10.32	7.77	5.73	2.98	2.06	0.94	0.00	1.17	0.72	0.72	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.00	0.51	0.51	0.50	0.61	0.56	0.93	0.74	0.78	1.67	15.25	12.97	12.06	11.10	8.66	6.57	4.19	3.08	2.00	1.95
45	11.83	9.01	8.79	8.28	5.73	3.90	2.98	2.16	1.14	0.00	0.90	0.55	0.55	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	0.51	0.51	0.50	0.61	0.56	0.93	0.74	0.78	1.67	12.73	10.07	9.85	9.00	6.56	4.68	4.13	3.12	2.14	1.89
60	13.56	11.54	10.83	8.79	6.75	5.12	2.37	2.16	1.14	0.00	0.90	0.55	0.55	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87	14.46	12.80	12.09	9.71	7.78	6.10	3.72	3.32	2.34	2.09
75	10.28	7.56	6.95	6.75	5.02	3.18	1.86	1.35	0.94	0.00	0.50	0.30	0.30	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.00	0.71	0.71	0.70	0.81	0.76	1.13	0.94	0.98	1.87	10.78	8.57	7.96	7.57	5.95	4.06	3.11	2.41	2.04	1.99
90	10.63	8.48	8.68	7.77	6.24	5.22	2.67	2.16	1.04	0.00	0.77	0.47	0.47	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.80	11.40	9.59	9.79	8.59	7.17	6.10	3.92	3.22	2.14	1.99
105	12.18	9.50	8.79	8.28	5.73	3.89	2.98	2.16	0.94	0.00	0.81	0.50	0.50	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.00	0.66	0.66	0.65	0.76	0.71	1.08	0.89	0.93	1.82	12.99	10.66	9.95	9.13	6.69	4.80	4.26	3.25	2.07	2.02
AVG.	12.48	10.14	9.46	8.72	6.47	4.68	2.73	2.06	1.01	0.00	0.90	0.55	0.55	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.00	0.61	0.61	0.60	0.71	0.66	1.03	0.84	0.88	1.77	13.38	11.30	10.62	9.53	7.40	5.56	3.98	3.12	2.11	1.99

PRELIMINARY RUN
DATE: JULY 24 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m									
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
---	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	--.---	--.---	--.---	--.---	--.---	--.---	--.---	--.---	--.---	--.---	--.---
15	0.0321	0.057	0.1452	0.0947	0.0272	0.0130	0.0215	0.0180	0.0170	0.0176	0.0190	3.093	16.190	17.622	11.497	2.440	1.163	1.920	1.691	1.522	1.502	1.777
30	0.1020	0.032	0.2197	0.1672	0.0177	0.0239	0.0213	0.0150	0.0242	0.0252	0.0210	0.650	6.349	10.649	14.192	1.110	1.500	1.339	0.942	1.522	1.502	1.317
45	0.0594	0.046	0.1519	0.1107	0.0209	0.0174	0.0200	0.0253	0.0181	0.0426	0.0220	5.369	9.041	13.730	10.000	1.930	1.163	1.339	1.691	1.211	2.040	1.522
60	0.0973	0.030	0.1505	0.1312	0.0212	0.0257	0.0200	0.0253	0.0204	0.0331	0.0220	0.792	6.349	14.324	11.056	1.420	1.717	1.339	1.691	1.366	2.215	1.522
AVG.	0.0727	0.041	0.1600	0.1260	0.0230	0.0200	0.0207	0.0211	0.0199	0.0296	0.0216	6.670	9.602	16.081	11.006	1.725	1.386	1.486	1.504	1.405	2.057	1.535

PRELIMINARY RUN
DATE: JULY 24 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	12.44	11.64	11.13	8.28	5.73	4.71	2.67	2.16	1.14	0.80
30	11.43	9.80	9.60	6.44	5.22	3.89	2.36	2.16	1.14	0.80
45	10.93	9.81	9.50	7.26	5.22	4.20	2.67	2.16	1.34	0.80
60	11.43	9.80	9.60	7.26	5.73	4.20	2.67	2.16	1.24	0.80
AVG.	11.56	10.26	9.96	7.31	5.48	4.25	2.59	2.16	1.22	0.80

	VELOCITY HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	1.08	0.66	0.66	0.26	0.26	0.26	0.26	0.26	0.26	0.26
30	0.76	0.46	0.46	0.18	0.18	0.18	0.18	0.18	0.18	0.18
45	0.81	0.49	0.49	0.20	0.20	0.20	0.20	0.20	0.20	0.20
60	0.81	0.49	0.49	0.19	0.19	0.19	0.19	0.19	0.19	0.19
AVG.	0.87	0.53	0.53	0.21	0.21	0.21	0.21	0.21	0.21	0.21

	GRAVITATIONAL HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.00
30	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.00
45	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.00
60	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.00
AVG.	0.00	0.64	0.64	0.63	0.74	0.69	1.06	0.87	0.91	1.00

	TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	13.52	12.94	12.43	9.17	6.73	5.66	3.99	3.29	2.31	2.06
30	12.19	10.90	10.70	7.25	6.14	4.76	3.60	3.21	2.23	1.90
45	11.74	10.94	10.63	8.09	6.16	5.09	3.93	3.23	2.45	2.00
60	12.24	10.93	10.73	8.08	6.66	5.08	3.92	3.22	2.34	1.99
AVG.	12.42	11.43	11.12	8.15	6.42	5.15	3.86	3.24	2.33	2.01

PRELIMINARY RUN
DATE: JULY 24 1986

PEAT SLURRY PUMP/PIPELINE SYSTEM TEST DATA

PEAT SLURRY PUMP | PEAT SLURRY PIPELINE

TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
15	778	2.395	0.73	40.8	12.44	2366.	8.96	108.93	81.23	20.31	99.89	74.49	24.43	18.22	24.46	35490.	134.40	7.40	2.26	19.6	1.00	12.45	24.0	1.001	0.0002581	0.00002390	27336.	29037.
30	791	2.395	0.73	37.5	11.43	1979.	7.49	100.89	75.23	18.81	92.52	68.99	18.77	14.00	20.29	29685.	112.35	6.20	1.89	19.6	1.15	12.00	5.5	1.007	0.0000588	0.00000546	100352.	106599.
45	771	2.395	0.73	35.9	10.93	2041.	7.73	102.88	76.72	19.18	94.34	70.35	18.52	13.81	19.63	30615.	115.95	6.40	1.95	19.8	0.96	5.75	6.0	1.009	0.0000640	0.00000595	95090.	101010.
60	785	2.395	0.73	37.5	11.43	2041.	7.73	103.69	77.32	19.33	95.06	70.90	19.38	14.45	20.38	30615.	115.95	6.40	1.95	20.3	1.06	5.05	7.0	1.006	0.0000749	0.00000696	81278.	86338.
AVG.	781	2.395	0.73	37.9	11.56	2107.	7.98	104.10	77.63	19.41	95.46	71.18	20.28	15.12	21.19	31601.	119.70	6.60	2.01	19.8	1.04	8.93	11.2	1.006	0.0001199	0.00001114	73955.	78558.

800 rpm, 0.50 inch clearance
Pipeline length 436.5 m

WATER RUN No.1
DATE: AUGUST 7 1986

PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP															PEAT SLURRY PIPELINE												
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
15	792	1.370	0.42	59.9	18.25	2931.	11.10	121.17	90.36	22.59	111.12	82.86	44.41	33.12	39.97	43965.	166.50	9.20	2.80	22.4	0.00	0.00	1.0	1.000	0.0000100	0.00000100	812000.	862549.
30	792	1.370	0.42	60.5	18.45	2931.	11.10	120.50	89.92	22.48	110.50	82.46	44.90	33.48	40.60	43965.	166.50	9.20	2.80	22.1	0.00	0.00	1.0	1.000	0.0000100	0.00000100	812000.	862549.
45	792	1.370	0.42	61.5	18.76	3036.	11.49	121.54	90.63	22.66	111.45	83.11	47.26	35.24	42.40	45540.	172.35	9.50	2.90	17.2	0.00	0.00	1.0	1.000	0.0000100	0.00000100	841000.	893354.
60	791	1.370	0.42	62.2	18.96	3005.	11.37	122.37	91.25	22.81	112.22	83.68	47.27	35.25	42.12	45075.	170.55	9.40	2.87	18.0	0.00	0.00	1.0	1.000	0.0000100	0.00000100	832300.	884113.
AVG.	792	1.370	0.42	61.0	18.61	2976.	11.27	121.42	90.54	22.64	111.34	83.03	45.96	34.27	41.27	44636.	169.05	9.33	2.84	19.9	0.00	0.00	1.0	1.000	0.0000100	0.00000100	824517.	875845.

800 rpm, 0.03 inch clearance
Pipeline length 436.5 m

WATER RUN No.1
DATE: AUGUST 7 1984

PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
----	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.0839	0.037	0.0418	0.0686	0.0251	0.0293	0.0178	0.0330	0.0259	0.0115	0.0249	15.630	16:190	7.784	11.287	3.460	4.043	2.440	4.541	3.571	1.582	3.431
30	0.0839	0.037	0.0476	0.0638	0.0251	0.0293	0.0208	0.0266	0.0259	0.0115	0.0249	15.630	16.190	8.865	11.886	3.460	4.043	2.864	3.671	3.571	1.582	3.431
45	0.0665	0.048	0.0400	0.0518	0.0261	0.0236	0.0250	0.0247	0.0232	0.0193	0.0244	13.209	22.540	8.000	10.359	3.860	3.489	3.695	3.647	3.432	2.848	3.600
60	0.0778	0.056	0.0406	0.0572	0.0267	0.0249	0.0238	0.0254	0.0213	0.0245	0.0246	15.235	25.714	7.946	11.190	3.870	3.598	3.451	3.671	3.090	3.544	3.550
AVG.	0.0780	0.045	0.0425	0.0604	0.0258	0.0268	0.0219	0.0274	0.0241	0.0167	0.0247	14.930	20.159	8.149	11.183	3.663	3.793	3.115	3.883	3.416	2.389	3.507

WATER RUN No.1
DATE: AUGUST 7 1986

PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
15	18.25	16.23	15.72	14.90	11.33	7.66	5.17	3.48	1.14	0.00	1.65	1.01	1.01	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.00	0.33	0.33	0.32	0.43	0.38	0.75	0.56	0.60	1.49	19.90	17.57	17.06	15.62	12.16	8.44	6.32	4.44	2.14	1.89
30	18.45	16.43	15.92	14.90	11.33	7.66	4.81	3.48	1.14	0.00	1.65	1.01	1.01	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.00	0.33	0.33	0.32	0.43	0.38	0.75	0.56	0.60	1.49	20.10	17.77	17.26	15.62	12.16	8.44	5.96	4.44	2.14	1.89
45	18.76	17.14	16.43	15.61	11.64	8.48	4.91	3.59	1.34	0.00	1.77	1.08	1.08	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.00	0.33	0.33	0.32	0.43	0.38	0.75	0.56	0.60	1.49	20.53	18.55	17.84	16.36	12.50	9.29	6.09	4.58	2.37	1.92
60	18.96	17.04	16.23	15.41	11.43	8.17	4.81	3.48	1.45	0.00	1.74	1.06	1.06	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.00	0.33	0.33	0.32	0.43	0.38	0.75	0.56	0.60	1.49	20.70	18.43	17.62	16.15	12.28	8.97	5.98	4.46	2.47	1.91
AVG.	18.61	16.71	16.08	15.21	11.43	7.99	4.93	3.51	1.27	0.00	1.70	1.04	1.04	0.41	0.41	0.41	0.41	0.41	0.41	0.41	0.00	0.33	0.33	0.32	0.43	0.38	0.75	0.56	0.60	1.49	20.31	18.08	17.45	15.94	12.28	8.79	6.09	4.48	2.28	1.90

WATER RUN No.2
DATE: AUGUST 10 1986

PUMP/PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP															PEAT SLURRY PIPELINE												
		DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
TIME	RPM	(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
---	-----	-.---	-.--	---.-	--.--	----.	----.--	---.--	---.--	--.--	---.--	---.--	---.--	---.--	---.--	-------.	---.--	--.--	-.--	--.-	-.--	--.--	---.-	-.---	-.-------	-.--------	-------.	-------.
15	1047	2.133	0.65	94.7	28.88	3769.	14.27	248.63	185.40	46.35	231.22	172.42	90.36	67.38	39.08	56535.	214.05	11.80	3.60	19.0	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.
30	1047	2.133	0.65	94.1	28.67	3769.	14.27	250.23	186.60	46.65	232.72	173.54	89.70	66.89	38.54	56535.	214.05	11.80	3.60	19.0	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.
45	1046	2.133	0.65	94.1	28.67	3769.	14.27	249.83	186.30	46.58	232.35	173.26	89.70	66.89	38.61	56535.	214.05	11.80	3.60	19.1	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.
60	1045	2.133	0.65	94.1	28.67	3769.	14.27	249.56	186.10	46.53	232.09	173.07	89.70	66.89	38.65	56535.	214.05	11.80	3.60	19.1	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.
75	1045	2.133	0.65	94.1	28.67	3769.	14.27	248.22	185.10	46.28	230.84	172.14	89.70	66.89	38.86	56535.	214.05	11.80	3.60	19.0	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.
90	1044	2.133	0.65	94.1	28.67	3769.	14.27	249.70	186.20	46.55	232.22	173.17	89.70	66.89	38.63	56535.	214.05	11.80	3.60	19.1	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.
AVG.	1046	2.133	0.65	94.2	28.71	3769.	14.27	249.36	185.95	46.49	231.91	172.93	89.81	66.97	38.73	56535.	214.05	11.80	3.60	19.1	0.00	0.00	1.0	1.000	0.0000108	0.00000100	1044000.	1108992.

1000 rpm, 0.03 inch clearance
Pipeline length 429.6 m

WATER RUN No.2
DATE: AUGUST 10 1984

PIPELINE SYSTEM CALCULATED TEST RESULTS

TIME	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR RUBBER HOSE	12" PIPELINE						AVG. FRICT. FACTOR FOR 12" PIPELINE	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m RUBBER HOSE	12" PIPELINE						AVG. HEAD LOSS m/100m FOR 12" PIPELINE
	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4		BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.		BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4		BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	
---	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
15	0.0442	0.062	0.0578	0.0437	0.0246	0.0328	0.0239	0.0291	0.0258	0.0139	0.0266	13.611	45.397	13.176	13.472	5.600	7.470	5.450	6.610	5.085	3.165	6.054
30	0.0422	0.054	0.0630	0.0436	0.0255	0.0319	0.0239	0.0291	0.0258	0.0139	0.0266	13.000	39.040	14.353	13.434	5.800	7.261	5.450	6.610	5.085	3.165	6.054
45	0.0460	0.045	0.0630	0.0462	0.0255	0.0319	0.0239	0.0291	0.0258	0.0139	0.0266	14.167	32.301	14.353	14.226	5.800	7.261	5.450	6.610	5.085	3.165	6.054
60	0.0422	0.054	0.0682	0.0448	0.0259	0.0318	0.0229	0.0291	0.0258	0.0139	0.0265	13.000	39.040	15.529	13.011	5.910	7.250	5.219	6.610	5.085	3.165	6.029
75	0.0422	0.054	0.0682	0.0448	0.0259	0.0309	0.0265	0.0236	0.0258	0.0139	0.0265	13.000	39.040	15.529	13.011	5.910	7.033	6.039	5.386	5.085	3.165	6.029
90	0.0460	0.049	0.0630	0.0462	0.0340	0.0246	0.0245	0.0258	0.0237	0.0139	0.0265	14.167	35.556	14.353	14.226	7.740	5.590	5.577	5.070	5.404	3.165	6.029
AVG.	0.0438	0.053	0.0639	0.0449	0.0269	0.0307	0.0243	0.0276	0.0255	0.0139	0.0266	13.491	38.413	14.549	13.030	6.127	6.980	5.531	6.200	5.085	3.165	6.042

WATER RUN No.2
DATE: AUGUST 18 1986

PIPELINE SYSTEM CALCULATED TEST RESULTS

PRESSURE HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	28.88	26.93	25.50	25.40	19.69	12.86	7.77	5.22	1.39	0.00
30	28.67	26.83	25.60	25.40	19.49	12.86	7.77	5.22	1.39	0.00
45	28.67	26.62	25.60	25.40	19.49	12.86	7.77	5.22	1.39	0.00
60	28.67	26.83	25.60	25.30	19.28	12.66	7.77	5.22	1.39	0.00
75	28.67	26.83	25.60	25.30	19.28	12.86	7.26	5.22	1.39	0.00
90	28.67	26.62	25.50	25.30	17.45	12.35	7.15	4.91	1.39	0.00
AVG.	28.71	26.78	25.57	25.35	19.11	12.74	7.58	5.17	1.39	0.00

VELOCITY HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66
30	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66
45	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66
60	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66
75	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66
90	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66
AVG.	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.66

GRAVITATIONAL HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--
15	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
30	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
45	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
60	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
75	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
90	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72
AVG.	0.00	0.56	0.56	0.55	0.66	0.61	0.98	0.79	0.83	1.72

TOTAL DYNAMIC HEAD (METERS OF WATER)

TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
15	31.61	29.16	27.73	26.61	21.01	14.13	9.41	6.67	2.88	2.38
30	31.40	29.06	27.83	26.61	20.81	14.13	9.41	6.67	2.88	2.38
45	31.40	28.85	27.83	26.61	20.81	14.13	9.41	6.67	2.88	2.38
60	31.40	29.06	27.83	26.51	20.60	13.93	9.41	6.67	2.88	2.38
75	31.40	29.06	27.83	26.51	20.60	14.13	8.90	6.67	2.88	2.38
90	31.40	28.85	27.73	26.51	18.77	13.62	8.79	6.36	2.88	2.38
AVG.	31.44	29.01	27.80	26.56	20.43	14.01	9.22	6.62	2.88	2.38

WATER RUN No.3 (WITHOUT ELBOW)
DATE: AUGUST 13 1986

PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP															PEAT SLURRY PIPELINE												
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s		
---	----	-.---	-.--	---.-	--.--	----.	----.--	---.--	---.--	--.--	---.--	---.--	---.--	---.--	---.--	------.	—	--.--	-.--	--.-	-.--	--.--	---.-	-.---	-.-------	-.--------	-------.	-------.
10	1041	2.362	0.72	144.5	44.03	2010.	7.61	233.61	174.20	43.55	217.26	162.01	73.46	54.78	33.81	20100.	76.10	6.30	1.92	19.5	0.00	0.00	1.0	1.000	0.0000100	0.00000100	556000.	591462.
20	1031	2.362	0.72	137.8	41.99	1979.	7.49	233.47	174.10	43.53	217.12	161.91	60.96	51.42	31.76	19790.	74.90	6.20	1.89	19.5	0.00	0.00	1.0	1.000	0.0000100	0.00000100	540100.	582221.
30	1035	2.362	0.72	137.8	41.99	1979.	7.49	233.74	174.30	43.58	217.38	162.10	60.96	51.42	31.72	19790.	74.90	6.20	1.89	19.5	0.00	0.00	1.0	1.000	0.0000100	0.00000100	540100.	582221.
AVG.	1036	2.362	0.72	140.0	42.67	1989.	7.53	233.61	174.20	43.55	217.25	162.01	70.46	52.54	32.43	19893.	75.30	6.23	1.90	19.5	0.00	0.00	1.0	1.000	0.0000100	0.00000100	551831.	585334.

1000 rpm, 0.03 inch clearance
Pipeline length 250.2 m

WATER RUN No.3 (WITHOUT ELBOW)
DATE: AUGUST 13 1986

PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)										HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR	12" PIPELINE					AVG. FRICT. FACTOR	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m	12" PIPELINE					AVG. HEAD LOSS m/100m
TIME	BETWEEN P1&P2	BETWEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BETWEEN P5&P6	BETWEEN P6&P7	BETWEEN P7&P8	BETWEEN P8&DIS.	FOR 12" PIPELINE	BETWEEN P1&P2	BETWEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BETWEEN P5&P6	BETWEEN P6&P7	BETWEEN P7&P8	BETWEEN P8&DIS.	FOR 12" PIPELINE
---	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	----.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
10	0.2099	5.371	0.0182	0.1469	0.0265	0.0366	0.0236	0.0450	0.0587	0.0311	10.389	1110.159	1.176	12.868	1.720	2.360	1.526	2.913	3.094	2.016
20	0.1026	5.332	0.0169	0.1280	0.0274	0.0313	0.0243	0.0464	0.0686	0.0307	15.500	1067.937	1.059	10.868	1.720	1.964	1.526	2.913	3.004	1.925
30	0.1963	5.317	0.0150	0.1369	0.0258	0.0313	0.0243	0.0464	0.0686	0.0299	16.667	1064.762	0.941	11.623	1.620	1.964	1.526	2.913	3.004	1.800
AVG.	0.1963	5.340	0.0167	0.1373	0.0266	0.0331	0.0241	0.0459	0.0600	0.0306	16.052	1080.953	1.059	11.786	1.687	2.099	1.526	2.913	3.034	1.940

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WATER RUN No.3 (WITHOUT ELBOW)
DATE: AUGUST 13 1986
                                                                  PIPELINE SYSTEM CALCULATED TEST RESULTS

                PRESSURE HEAD (METERS OF WATER)                      VELOCITY HEAD (METERS OF WATER)              GRAVITATIONAL HEAD (METERS OF WATER)                   TOTAL DYNAMIC HEAD (METERS OF WATER)
TIME   P1    P2    P3    P4    P5    P6    P7    P8   PDIS.   P1   P2   P3   P4   P5   P6   P7   P8  PDIS.   P1   P2   P3   P4   P5   P6   P7   P8  PDIG.   P1    P2    P3    P4    P5    P6    P7    P8   PDIS.
      (m)   (m)   (m)   (m)   (m)   (m)   (m)   (m)   (m)    (m)  (m)  (m)  (m)  (m)  (m)  (m)  (m)  (m)    (m)  (m)  (m)  (m)  (m)  (m)  (m)  (m)  (m)    (m)   (m)   (m)   (m)   (m)   (m)   (m)   (m)   (m)
----  --.-- --.-- --.-- --.-- --.-- --.-- --.-- --.-- --.--   -.-- -.-- -.-- -.-- -.-- -.-- -.-- -.-- -.--   -.-- -.-- -.-- -.-- -.-- -.-- -.-- -.-- -.--   --.-- --.-- --.-- --.-- --.-- --.-- --.-- --.-- --.--
  10  44.03 40.39  5.42  5.62  3.79  2.67  1.65  1.24  0.00   0.78 0.48 0.48 0.19 0.19 0.19 0.19 0.19 0.19   0.00 0.63 0.63 0.62 0.73 0.68 1.05 0.86 1.79   44.81 41.50  6.53  6.43  4.71  3.54  2.89  2.29  1.98
  20  41.99 38.86  5.22  5.42  3.59  2.67  1.65  1.24  0.00   0.75 0.46 0.46 0.18 0.18 0.18 0.18 0.18 0.18   0.00 0.63 0.63 0.62 0.73 0.68 1.05 0.86 1.79   42.74 39.95  6.31  6.22  4.50  3.53  2.88  2.28  1.97
  30  41.99 38.65  5.11  5.32  3.59  2.67  1.65  1.24  0.00   0.75 0.46 0.46 0.18 0.18 0.18 0.18 0.18 0.18   0.00 0.63 0.63 0.62 0.73 0.68 1.05 0.86 1.79   42.74 39.74  6.20  6.12  4.50  3.53  2.88  2.28  1.97

AVG.' 42.67 39.30  5.25  5.45  3.66  2.67  1.65  1.24  0.00   0.76 0.47 0.47 0.18 0.18 0.18 0.18 0.18 0.18   0.00 0.63 0.63 0.62 0.73 0.68 1.05 0.86 1.79   43.43 40.40  6.35  6.26  4.57  3.53  2.88  2.28  1.97
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WATER RUN No.3 (WITH ELBOW)
DATE: AUGUST 13 1986

PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP															PEAT SLURRY PIPELINE											
TIME	RPM	DEPTH OF SUBMISSION		DISCHARGE PRESSURE		FLOW RATE		POWER DEMAND		ENERGY DEMAND	BRAKE HORSEPOWER		HYDRAULIC HORSEPOWER			TOTAL FLOW		VELOCITY		TEMP	SOLIDS CONTENT	ASH CONTENT	VISCOSITY	SPECIFIC GRAVITY	KINEMATIC VISCOSITY		REYNOLDS NUMBER	REYNOLDS NUMBER
		(ft.)	(m)	(ft.)	(m)	GPM	m^3PM	HP.	Kw	Kwh	HP	Kw	HP	Kw	Eff. %	GAL	m^3	ft./s	m/s	°C	%	%	cps		ft²/s	m²/s	12" PIPELINE	RUBBER HOSE
10	1042	2.953	0.90	73.2	22.30	3570.	13.51	262.04	196.00	49.00	244.44	182.20	66.06	49.26	27.02	53550.	135.10	11.20	3.41	10.3	0.02	0.00	1.0	1.000	0.0000100	0.00000100	900900.	1050461.
20	1042	2.953	0.90	72.1	21.99	3570.	13.51	264.45	197.20	49.30	245.94	183.40	65.13	48.57	26.40	53550.	135.10	11.20	3.41	10.4	0.00	0.00	1.0	1.000	0.0000100	0.00000100	900900.	1050461.
AVG.	1042	2.953	0.90	72.7	22.15	3570.	13.51	263.65	196.60	49.15	245.19	182.84	65.60	48.92	26.75	53550.	135.10	11.20	3.41	10.4	0.00	0.00	1.0	1.000	0.0000100	0.00000100	900900.	1050461.

1000 rpm, 0.03 inch clearance
Pipeline length 264 m

WATER RUN No.3 (WITH ELBOW)
DATE: AUGUST 13 1986

PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)											HEAD LOSS m/100m										
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR	12" PIPELINE						AVG. FRICT. FACTOR	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m	12" PIPELINE						AVG. HEAD LOSS m/100m
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE	BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4	RUBBER HOSE	BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&P9	BEWTEEN P9&DIS.	FOR 12" PIPELINE
---	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
10	0.0750	0.059	0.0530	0.0640	0.0304	0.0439	0.0100	0.0357	0.1457	0.0354	0.0340	20.944	30.730	10.024	17.690	6.210	8.968	3.605	7.302	29.767	7.238	6.939
20	0.0810	0.030	0.0530	0.0681	0.0299	0.0449	0.0100	0.0357	0.1570	0.0308	0.0340	22.611	19.365	10.024	18.830	6.110	9.170	3.605	7.302	32.093	6.286	6.939
AVG.	0.0780	0.045	0.0530	0.0661	0.0302	0.0444	0.0100	0.0357	0.1514	0.0331	0.0340	21.778	29.048	10.024	18.264	6.160	9.069	3.605	7.302	30.930	6.762	6.939

WATER RUN No.3 (WITH ELBOW)
DATE: AUGUST 13 1984

PIPELINE SYSTEM CALCULATED TEST RESULTS

	PRESSURE HEAD (METERS OF WATER)										VELOCITY HEAD (METERS OF WATER)										GRAVITATIONAL HEAD (METERS OF WATER)										TOTAL DYNAMIC HEAD (METERS OF WATER)									
TIME	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)	P1 (m)	P2 (m)	P3 (m)	P4 (m)	P5 (m)	P6 (m)	P7 (m)	P8 (m)	P9 (m)	PDIS. (m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
10	22.30	18.67	17.45	17.45	11.13	6.75	4.81	2.97	1.65	0.00	2.45	1.50	1.50	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.00	0.81	0.81	0.80	0.91	0.86	1.23	1.04	1.08	1.97	24.75	20.98	19.76	18.84	12.63	8.20	6.63	4.60	3.32	2.56
20	21.99	18.06	17.45	17.45	11.23	6.75	4.81	2.97	1.55	0.00	2.45	1.50	1.50	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.00	0.81	0.81	0.80	0.91	0.86	1.23	1.04	1.08	1.97	24.44	20.37	19.76	18.84	12.73	8.20	6.63	4.60	3.22	2.56
AVG.	22.15	18.37	17.45	17.45	11.18	6.75	4.81	2.97	1.60	0.00	2.45	1.50	1.50	0.59	0.59	0.59	0.59	0.59	0.59	0.59	0.00	0.81	0.81	0.80	0.91	0.86	1.23	1.04	1.08	1.97	24.60	20.68	19.76	18.84	12.68	8.20	6.63	4.60	3.27	2.56

WATER RUN No.4
DATE: AUGUST 13 1986

PIPELINE SYSTEM TEST DATA

		PEAT SLURRY PUMP														PEAT SLURRY PIPELINE												
TIME	RPM	DEPTH OF SUBMISSION (ft.)	DEPTH OF SUBMISSION (m)	DISCHARGE PRESSURE (ft.)	DISCHARGE PRESSURE (m)	FLOW RATE GPM	FLOW RATE m^3PM	POWER DEMAND HP.	POWER DEMAND Kw	ENERGY DEMAND Kwh	BRAKE HORSEPOWER HP	BRAKE HORSEPOWER Kw	HYDRAULIC HORSEPOWER HP	HYDRAULIC HORSEPOWER Kw	Eff. %	TOTAL FLOW GAL	TOTAL FLOW m^3	VELOCITY ft./s	VELOCITY m/s	TEMP °C	SOLIDS CONTENT %	ASH CONTENT %	VISCOSITY cps	SPECIFIC GRAVITY	KINEMATIC VISCOSITY ft²/s	KINEMATIC VISCOSITY m²/s	REYNOLDS NUMBER 12" PIPELINE	REYNOLDS NUMBER RUBBER HOSE
10	1045	1.640	0.50	123.7	37.70	3444.	13.04	240.04	179.00	44.75	223.24	166.47	107.79	80.38	48.28	34440.	130.40	10.80	3.29	18.6	0.00	0.00	1.0	1.000	0.0000100	0.00000100	954100.	1013495.
20	1044	1.968	0.60	97.2	29.64	3895.	14.74	243.00	181.00	45.45	226.73	169.07	95.79	71.43	42.25	38950.	147.40	12.20	3.72	18.7	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1078000.	1145950.
30	1043	1.804	0.55	97.1	29.59	3895.	14.74	244.07	182.00	45.50	226.90	169.26	95.63	71.31	42.13	38950.	147.40	12.20	3.72	18.9	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1078000.	1145950.
40	1043	1.804	0.55	95.4	29.08	3863.	14.62	243.66	181.70	45.43	226.61	168.98	93.21	69.51	41.14	38630.	146.20	12.10	3.69	18.9	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1070100.	1136716.
50	1043	1.804	0.55	110.5	33.67	3601.	13.63	242.99	181.20	45.30	225.99	168.52	100.62	75.03	44.52	36010.	136.30	11.30	3.44	18.9	0.00	0.00	1.0	1.000	0.0000100	0.00000100	997600.	1059703.
60	1043	1.837	0.56	110.5	33.68	3601.	13.63	242.72	181.00	45.25	225.73	168.33	100.66	75.06	44.59	36010.	136.30	11.30	3.44	19.0	0.00	0.00	1.0	1.000	0.0000100	0.00000100	997600.	1059703.
70	1042	1.804	0.55	120.5	36.73	3319.	12.56	240.45	179.30	44.83	223.62	166.75	101.15	75.43	45.24	33190.	125.60	10.40	3.17	19.2	0.00	0.00	1.0	1.000	0.0000100	0.00000100	919300.	976529.
80	1041	1.739	0.53	120.4	36.71	3350.	12.68	240.71	179.50	44.88	223.87	166.94	102.07	76.11	45.59	33500.	126.80	10.50	3.20	19.2	0.00	0.00	1.0	1.000	0.0000100	0.00000100	928000.	985770.
90	1037	1.739	0.53	70.3	21.42	4083.	15.46	251.04	187.20	46.80	233.47	174.10	72.60	54.14	31.10	40830.	154.60	12.80	3.90	19.2	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1131000.	1201407.
100	1038	1.870	0.57	72.1	21.97	4083.	15.46	250.23	186.60	46.65	232.72	173.54	74.47	55.53	32.00	40830.	154.60	12.80	3.90	19.3	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1131000.	1201407.
110	1037	1.804	0.55	89.7	27.35	3989.	15.10	246.08	183.50	45.88	228.86	170.66	90.55	67.52	39.56	39890.	151.00	12.50	3.81	19.3	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1104900.	1173603.
120	1036	1.804	0.55	89.7	27.35	3989.	15.10	246.61	183.90	45.98	229.35	171.03	90.55	67.52	39.48	39890.	151.00	12.50	3.81	19.3	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1104900.	1173603.
AVG.	1041	1.801	0.55	99.8	30.41	3759.	14.23	244.37	182.23	45.56	227.26	169.47	93.76	69.91	41.32	37593.	142.30	11.70	3.59	19.0	0.00	0.00	1.0	1.000	0.0000100	0.00000100	1046700.	1111860.

1000 rpm, 0.03 inch clearance
Pipeline length 250.2 m

WATER RUN No.4
DATE: AUGUST 13 1986

PIPELINE SYSTEM CALCULATED TEST RESULTS

	FRICTION FACTOR (UNITLESS)										HEAD LOSS m/100m									
	RUBBER HOSE AND VALVE SKID			AVG. FRICT. FACTOR	12" PIPELINE					AVG. FRICT. FACTOR	RUBBER HOSE AND VALVE SKID			AVG. HEAD LOSS m/100m	12" PIPELINE					AVG. HEAD LOSS m/100m
TIME	BETWEEN P1&P2	BEWTEEN P2&P3	BETWEEN P3&P4	RUBBER HOSE	BETWEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&DIS.	FOR 12" PIPELINE	BEWTEEN P1&P2	BEWTEEN P2&P3	BEWTEEN P3&P4	RUBBER HOSE	BEWTEEN P4&P5	BEWTEEN P5&P6	BEWTEEN P6&P7	BEWTEEN P7&P8	BEWTEEN P8&DIS.	FOR 12" PIPELINE
---	-.----	--.---	-.----	-.----	-.----	-.----	-.----	-.----	-.----	-.----	---.---	----.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---	---.---
10	0.0600	1.312	0.0278	0.0474	0.0192	0.0287	0.0155	0.0309	0.0464	0.0227	15.444	796.190	5.294	12.189	3.660	5.466	2.950	5.874	8.034	4.326
20	0.0444	0.521	0.0426	0.0403	0.0234	0.0300	0.0191	0.0323	0.0515	0.0259	14.611	404.444	10.353	13.245	5.700	7.300	4.640	7.864	12.515	6.310
30	0.0444	0.525	0.0377	0.0391	0.0238	0.0301	0.0180	0.0323	0.0515	0.0259	14.611	407.619	9.176	12.060	5.800	7.320	4.390	7.864	12.515	6.310
40	0.0446	0.517	0.0383	0.0394	0.0242	0.0298	0.0193	0.0329	0.0472	0.0262	14.444	394.603	9.176	12.755	5.800	7.126	4.624	7.864	11.200	6.265
50	0.0687	0.844	0.0362	0.0553	0.0235	0.0333	0.0180	0.0329	0.0484	0.0266	19.333	559.683	7.529	15.547	4.800	6.923	3.920	6.845	10.061	5.527
60	0.0727	0.844	0.0380	0.0565	0.0238	0.0323	0.0187	0.0355	0.0484	0.0264	20.444	560.000	6.235	15.807	4.700	6.721	3.897	7.379	10.061	5.401
70	0.0705	1.303	0.0266	0.0542	0.0236	0.0290	0.0174	0.0360	0.0535	0.0261	16.033	734.286	4.706	12.943	4.170	5.263	3.075	6.359	9.440	4.602
80	0.0696	1.273	0.0260	0.0536	0.0234	0.0292	0.0184	0.0340	0.0525	0.0258	16.944	731.111	4.824	13.057	4.220	5.263	3.310	6.117	9.440	4.640
90	0.0453	0.034	0.0348	0.0390	0.0270	0.0347	0.0213	0.0370	0.0580	0.0290	16.309	28.889	9.294	14.113	7.230	9.271	5.704	10.097	15.706	7.973
100	0.0532	0.030	0.0392	0.0454	0.0274	0.0343	0.0209	0.0387	0.0565	0.0290	19.222	25.714	10.471	16.415	7.330	9.170	5.507	10.340	15.092	7.973
110	0.0596	0.330	0.0383	0.0495	0.0252	0.0303	0.0187	0.0325	0.0519	0.0267	20.556	260.571	9.765	17.094	6.420	7.733	4.765	8.381	13.252	6.822
120	0.0596	0.330	0.0383	0.0495	0.0252	0.0303	0.0187	0.0325	0.0519	0.0267	20.556	260.571	9.765	17.094	6.420	7.733	4.765	8.381	13.252	6.822
AVG.	0.0577	0.655	0.0347	0.0474	0.0241	0.0311	0.0187	0.0340	0.0515	0.0266	17.449	431.640	8.049	14.434	5.534	7.189	4.384	7.767	11.709	6.000

WATER RUN No.4
DATE: AUGUST 13 1986

PIPELINE SYSTEM CALCULATED TEST RESULTS

TIME	PRESSURE HEAD (METERS OF WATER)									VELOCITY HEAD (METERS OF WATER)									GRAVITATIONAL HEAD (METERS OF WATER)									TOTAL DYNAMIC HEAD (METERS OF WATER)								
	P1	P2	P3	P4	P5	P6	P7	P8	PDIS.	P1	P2	P3	P4	P5	P6	P7	P8	PDIS.	P1	P2	P3	P4	P5	P6	P7	P8	PDIS.	P1	P2	P3	P4	P5	P6	P7	P8	PDIS.
	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)	(m)
----	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	-.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--	--.--
10	37.70	35.39	10.31	10.72	6.95	4.30	2.67	1.65	0.00	2.20	1.40	1.40	0.55	0.55	0.55	0.55	0.55	0.55	0.00	0.41	0.41	0.40	0.51	0.46	0.83	0.64	1.57	39.90	37.20	12.12	11.67	8.01	5.31	4.05	2.84	2.12
20	29.64	27.64	14.90	15.10	9.29	5.73	3.38	1.95	0.00	2.92	1.78	1.78	0.71	0.71	0.71	0.71	0.71	0.71	0.00	0.51	0.51	0.50	0.61	0.56	0.93	0.74	1.67	32.56	29.93	17.19	16.31	10.61	7.00	5.02	3.40	2.38
30	29.59	27.64	14.80	15.10	9.19	5.62	3.38	1.95	0.00	2.92	1.78	1.78	0.71	0.71	0.71	0.71	0.71	0.71	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	32.51	29.88	17.04	16.26	10.46	6.84	4.97	3.35	2.33
40	29.08	27.13	14.70	15.00	9.09	5.62	3.28	1.85	0.00	2.87	1.76	1.76	0.69	0.69	0.69	0.69	0.69	0.69	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	31.95	29.35	16.92	16.14	10.34	6.82	4.85	3.23	2.31
50	33.67	30.70	13.87	13.37	8.38	5.01	2.97	1.75	0.00	2.50	1.53	1.53	0.60	0.60	0.60	0.60	0.60	0.60	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	36.17	32.69	15.86	14.42	9.54	6.12	4.45	3.04	2.22
60	33.60	30.50	12.86	13.27	8.38	5.11	3.08	1.75	0.00	2.50	1.53	1.53	0.60	0.60	0.60	0.60	0.60	0.60	0.00	0.47	0.47	0.46	0.57	0.52	0.89	0.70	1.63	36.10	32.50	14.86	14.33	9.55	6.23	4.57	3.05	2.23
70	36.73	34.06	10.93	11.33	7.05	4.50	2.82	1.70	0.00	2.12	1.30	1.30	0.51	0.51	0.51	0.51	0.51	0.51	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	38.85	35.82	12.69	12.29	8.12	5.52	4.21	2.90	2.13
80	36.71	34.06	11.03	11.43	7.10	4.55	2.77	1.70	0.00	2.16	1.32	1.32	0.52	0.52	0.52	0.52	0.52	0.52	0.00	0.44	0.44	0.43	0.54	0.49	0.86	0.67	1.60	38.87	35.82	12.79	12.38	8.16	5.56	4.15	2.89	2.12
90	21.42	19.28	18.37	18.77	11.43	6.90	4.10	2.21	0.00	3.21	1.96	1.96	0.78	0.78	0.78	0.78	0.78	0.78	0.00	0.44	0.44	0.43	0.54	0.49	0.86	0.67	1.60	24.63	21.68	20.77	19.98	12.75	8.17	5.74	3.66	2.38
100	21.97	19.28	18.47	18.77	11.33	6.85	4.10	2.16	0.00	3.21	1.96	1.96	0.78	0.78	0.78	0.78	0.78	0.78	0.00	0.48	0.48	0.47	0.58	0.53	0.90	0.71	1.64	25.18	21.72	20.91	20.02	12.69	8.16	5.78	3.65	2.42
110	27.35	24.38	15.92	16.23	9.78	5.93	3.53	2.01	0.00	3.06	1.87	1.87	0.74	0.74	0.74	0.74	0.74	0.74	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	30.41	26.71	18.25	17.42	11.08	7.18	5.15	3.44	2.36
120	27.35	24.38	15.92	16.23	9.78	5.93	3.53	2.01	0.00	3.06	1.87	1.87	0.74	0.74	0.74	0.74	0.74	0.74	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	30.41	26.71	18.25	17.42	11.08	7.18	5.15	3.44	2.36
AVG.	30.41	27.87	14.27	14.61	8.97	5.50	3.30	1.89	0.00	2.73	1.67	1.67	0.66	0.66	0.66	0.66	0.66	0.66	0.00	0.46	0.46	0.45	0.56	0.51	0.88	0.69	1.62	33.14	30.00	16.40	15.72	10.19	6.67	4.84	3.24	2.28

APPENDIX B

WATER SUPPLY PUMP/PIPELINE SYSTEM
TEST DATA

TEST No.1, RUN No. 1
DATE: JULY 26, & 28 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

TIME	HIGH PRESSURE WATER PUMP NO.01 DISCHARGE PRESSURE -		HIGH PRESSURE WATER PUMP No.02 - DISCHARGE PRESSURE		HYDROMONITOR No.01 FLOW RATE		HYDROMONITOR No.01 DISCHARGE PRESSURE		HYDROMONITOR No.01 SIZE OF NOZZLE		HYDROMONITOR No.02 FLOW RATE		HYDROMONITOR No.02 DISCHARGE PRESSURE		HYDROMONITOR No.02 SIZE OF NOZZLE		HYDROMONITOR No.03 FLOW RATE		HYDROMONITOR No.03 SIZE OF NOZZLE		PRESSURE DROP IN PIPELINE HYDROMONITOR 01	PRESSURE DROP IN PIPELINE HYDROMONITOR 02	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	175±10	1207±69	165±10	1138± 69	540	2.044	177	1220	1.25	3.18	550	2.082	155	1069	1.25	3.18	0	0.000	0.00	0.00	-0.06±42.76	43.02±43.02	16350	61.9	1090	4.13
30	175±10	1207±69	165±10	1138± 69	540	2.044	177	1220	1.25	3.18	550	2.082	155	1069	1.25	3.18	0	0.000	0.00	0.00	-0.06±42.76	43.02±43.02	16350	61.9	1090	4.13
45	200±10	1379±69	165±10	1138± 69	570	2.158	200	1379	1.25	3.18	480	1.817	135	931	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	129.06±43.02	15750	59.6	1050	3.97
60	180±10	1241±69	165±10	1138± 69	540	2.044	180	1241	1.25	3.18	450	1.703	112	772	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	220.19±43.02	14850	56.2	990	3.75
75	180±10	1241±69	165±10	1138± 69	540	2.044	180	1241	1.25	3.18	500	1.893	145	1000	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	86.04±43.02	15600	59.1	1040	3.94
90	180±10	1241±69	165±10	1138± 69	540	2.044	180	1241	1.25	3.18	500	1.893	145	1000	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	86.04±43.02	15600	59.1	1040	3.94
105	180±10	1241±69	165±10	1138± 69	540	2.044	180	1241	1.25	3.18	500	1.893	145	1000	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	86.04±43.02	15600	59.1	1040	3.94
120	180±10	1241±69	165±10	1138± 69	540	2.044	180	1241	1.25	3.18	500	1.893	145	1000	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	86.04±43.02	15600	59.1	1040	3.94
135	165±10	1138±69	190±10	1310± 69	525	1.987	165	1138	1.25	3.18	570	2.158	192	1324	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	-0.73±43.02	16425	62.2	1095	4.14
150	165±10	1138±69	190±10	1310± 69	525	1.987	165	1138	1.25	3.18	570	2.158	192	1324	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	-0.73±43.02	16425	62.2	1095	4.14
165	165±10	1138±69	190±10	1310± 69	520	1.968	165	1138	1.25	3.18	570	2.158	192	1324	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	-0.73±43.02	16350	61.9	1090	4.13
180	165±10	1138±69	190±10	1310± 69	520	1.968	165	1138	1.25	3.18	560	2.120	192	1324	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	-0.73±43.02	16200	61.3	1080	4.09
AVG.	176±10	1213±69	173±10	1195± 69	537	2.031	176	1215			525	1.988	159	1095			0	0.000			-1.34±42.76	62.71±43.02	15925	60.3	1062	4.02

TEST No.1, RUN No.2
DATE: JULY 28 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		HIGH PRESSURE WATER PUMP No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR 01	HYDROMONITOR 02	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
30	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
45	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
60	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
75	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
90	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
105	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
120	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
135	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
150	32± 0	221± 0	200± 5	1379± 34	100	0.681	22	152	1.25	3.10	560	2.120	190	1310	1.25	3.10	0	0.000	0.00	0.00	42.76± 0.00	43.02±21.20	11100	42.0	740	2.80
165	15± 0	103± 0	200± 5	1379± 34	80	0.303	10	69	1.25	3.10	550	2.082	190	1310	1.25	3.10	0	0.000	0.00	0.00	21.07± 0.00	43.02±21.20	9450	35.0	630	2.38
180	15± 0	103± 0	200± 5	1379± 34	80	0.303	10	69	1.25	3.10	550	2.082	190	1310	1.25	3.10	0	0.000	0.00	0.00	21.07± 0.00	43.02±21.20	9450	35.0	630	2.38
AVG.	29± 0	201± 0	200± 5	1379± 34	163	0.618	20	138			558	2.114	190	1310			0	0.000			39.15± 0.00	43.02±21.20	10025	41.0	722	2.73

TEST No.1, RUN No.3
DATE: JULY 28 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

TIME	HIGH PRESSURE WATER PUMP NO.01 DISCHARGE PRESSURE		HIGH PRESSURE WATER PUMP No.02 DISCHARGE PRESSURE		HYDROMONITOR No.01 FLOW RATE		HYDROMONITOR No.01 DISCHARGE PRESSURE		HYDROMONITOR No.01 SIZE OF NOZZLE		HYDROMONITOR No.02 FLOW RATE		HYDROMONITOR No.02 DISCHARGE PRESSURE		HYDROMONITOR No.02 SIZE OF NOZZLE		HYDROMONITOR No.03 FLOW RATE		HYDROMONITOR No.03 SIZE OF NOZZLE		PRESSURE DROP IN PIPELINE HYDROMONITOR #1	PRESSURE DROP IN PIPELINE HYDROMONITOR #2	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	140±10	965±69	145±10	1000± 69	700	2.650	135	931	1.50	3.81	710	2.688	135	931	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	43.02±43.02	21150	80.1	1410	5.34
30	140±10	965±69	145±10	1000± 69	700	2.650	135	931	1.50	3.81	710	2.688	135	931	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	43.02±43.02	21150	80.1	1410	5.34
45	165±10	1138±69	180±20	1241±130	750	2.839	157	1082	1.50	3.81	760	2.877	160	1103	1.50	3.81	0	0.000	0.00	0.00	34.70±42.76	96.04±86.04	22650	85.7	1510	5.72
60	165±10	1138±69	180±20	1241±130	750	2.839	157	1082	1.50	3.81	760	2.877	160	1103	1.50	3.81	0	0.000	0.00	0.00	34.70±42.76	86.04±86.04	22650	85.7	1510	5.72
75	190±10	1310±69	180±20	1241±130	840	3.180	157	1082	1.50	3.81	900	3.407	155	1069	1.75	4.45	0	0.000	0.00	0.00	141.29±42.75	107.24±86.03	26100	98.8	1740	6.59
90	190±10	1310±69	200±10	1379± 69	800	3.028	185	1276	1.50	3.81	800	3.028	177	1220	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	99.13±43.02	24000	90.8	1600	6.06
105	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
120	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
135	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
150	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
165	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
180	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
195	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
210	190±10	1310±69	205±10	1413± 69	800	3.028	185	1276	1.50	3.81	830	3.142	185	1276	1.50	3.81	0	0.000	0.00	0.00	21.07±42.76	85.41±43.02	24450	92.6	1630	6.17
AVG.	179±10	1236±69	191±12	1315± 84	781	2.958	172	1185			806	3.050	172	1183			0	0.000			31.60±42.76	81.90±52.24	23807	90.1	1587	6.01

TEST No.1, RUN No.4
DATE: AUGUST 1 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

TIME	HIGH PRESSURE WATER PUMP NO.01 DISCHARGE PRESSURE		HIGH PRESSURE WATER PUMP No.02 DISCHARGE PRESSURE		HYDROMONITOR No.01 FLOW RATE		HYDROMONITOR No.01 DISCHARGE PRESSURE		HYDROMONITOR No.01 SIZE OF NOZZLE		HYDROMONITOR No.02 FLOW RATE		HYDROMONITOR No.02 DISCHARGE PRESSURE		HYDROMONITOR No.02 SIZE OF NOZZLE		HYDROMONITOR No.03 FLOW RATE		HYDROMONITOR No.03 SIZE OF NOZZLE		PRESSURE DROP IN PIPELINE HYDROMONITOR #1	PRESSURE DROP IN PIPELINE HYDROMONITOR #2	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	230±10	1586±69	160±20	1103±138	625	2.366	220	1517	1.25	3.18	720	2.725	140	965	1.50	3.81	0	0.000	0.00	0.00	42.76±42.76	86.04±86.04	20175	76.4	1345	5.09
30	230±10	1586±69	160±20	1103±138	625	2.366	220	1517	1.25	3.18	720	2.725	140	965	1.50	3.81	0	0.000	0.00	0.00	42.76±42.76	86.04±86.04	20175	76.4	1345	5.09
45	230±10	1586±69	160±20	1103±138	625	2.366	220	1517	1.25	3.18	720	2.725	140	965	1.50	3.81	0	0.000	0.00	0.00	42.76±42.76	86.04±86.04	20175	76.4	1345	5.09
60	230±10	1586±69	150±20	1034±138	630	2.385	220	1517	1.25	3.18	820	3.104	115	793	1.75	4.45	0	0.000	0.00	0.00	42.76±42.76	150.26±86.03	21750	82.3	1450	5.49
75	230±10	1586±69	150±20	1034±138	630	2.385	220	1517	1.25	3.18	820	3.104	115	793	1.75	4.45	0	0.000	0.00	0.00	42.76±42.76	150.26±86.03	21750	82.3	1450	5.49
90	120± 5	827±34	190±20	1310±138	660	2.498	120	827	1.50	3.81	945	3.577	153	1055	1.75	4.45	0	0.000	0.00	0.00	0.00±21.07	158.98±86.04	24075	91.1	1605	6.08
105	140± 5	965±34	190±20	1310±138	705	2.669	140	965	1.50	3.81	945	3.577	153	1055	1.75	4.45	0	0.000	0.00	0.00	0.00±21.07	158.98±86.04	24750	93.7	1650	6.25
120	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	930	3.520	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25800	97.7	1720	6.51
135	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	930	3.520	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25800	97.7	1720	6.51
150	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	935	3.539	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25875	97.9	1725	6.53
165	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	935	3.539	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25875	97.9	1725	6.53
180	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	935	3.539	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25875	97.9	1725	6.53
195	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	935	3.539	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25875	97.9	1725	6.53
210	180± 5	1241±34	190±20	1310±138	790	2.990	158	1089	1.50	3.81	935	3.539	153	1055	1.75	4.45	0	0.000	0.00	0.00	94.19±21.07	158.98±86.04	25875	97.9	1725	6.53
AVG.	191± 7	1315±47	178±20	1226±138	716	2.712	176	1214			873	3.305	145	998			0	0.000			62.37±20.02	142.10±86.04	23845	90.3	1590	6.02

TEST No.2, RUN No.5
DATE: AUGUST 10 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP				HYDROMONITOR						HYDROMONITOR						HYDROMONITOR				PRESSURE DROP IN PIPELINE					
	NO.01		No.02		No.01						No.02						No.03									
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR #1	HYDROMONITOR #2	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	140±10	965±69	180±20	1241±130	900	3.407	132	910	1.75	4.45	900	3.407	138	951	1.75	4.45	0	0.000	1.25	3.18	34.00±42.76	100.01±86.03	27000	102.2	1800	6.81
30	90±10	621±69	20± 5	138± 34	740	2.801	87	600	1.75	4.45	340	1.287	17	117	1.75	4.45	340	1.287	1,25	3.18	13.01±42.76	13.09±21.20	21300	80.6	1420	5.38
45	140±10	965±69	180±20	1241±130	900	3.407	132	910	1.75	4.45	900	3.407	138	951	1.75	4.45	0	0.000	1.25	3.18	34.00±42.76	100.01±86.03	27000	102.2	1800	6.81
60	136±10	938±69	180±20	1241±130	900	3.407	132	910	1.75	4.45	900	3.407	138	951	1.75	4.45	0	0.000	1.25	3.18	17.35±42.76	100.01±86.03	27000	102.2	1800	6.81
75	80±10	552±69	180±20	1241±130	680	2.574	80	552	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	0.00±42.76	206.37±86.04	28050	106.2	1870	7.08
90	80±10	552±69	180±20	1241±130	680	2.574	80	552	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	0.00±42.76	206.37±86.04	28050	106.2	1870	7.08
105	80±10	552±69	180±20	1241±130	680	2.574	80	552	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	0.00±42.76	206.37±86.04	28050	106.2	1870	7.08
120	80±10	552±69	180±20	1241±130	680	2.574	80	552	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	0.00±42.76	206.37±86.04	28050	106.2	1870	7.08
135	80±10	552±69	180±20	1241±130	680	2.574	80	552	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	0.00±42.76	206.37±86.04	28050	106.2	1870	7.08
150	80±10	552±69	180±20	1241±130	680	2.574	77	531	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	13.01±42.76	206.37±86.04	28050	106.2	1870	7.08
165	80±10	552±69	180±20	1241±130	680	2.574	77	531	1.75	4.45	865	3.274	132	910	1.75	4.45	325	1.230	1.25	3.18	13.01±42.76	206.37±86.04	28050	106.2	1870	7.08
180	170±10	1172±69	180±20	1241±130	615	2.328	60	414	1.75	4.45	870	3.293	137	945	1.75	4.45	0	0.000	1.25	3.18	469.71±42.76	104.55±86.03	22275	84.3	1485	5.62
195	170±10	1172±69	180±20	1241±130	615	2.328	60	414	1.75	4.45	870	3.293	137	945	1.75	4.45	0	0.000	1.25	3.18	469.71±42.76	104.55±86.03	22275	84.3	1485	5.62
AVG.	108±10	746±69	168±19	1156±130	725	2.746	89	614			833	3.155	125	864			201	0.761			81.84±42.76	102.25±81.05	26400	99.9	1760	6.66

TEST No.2, RUN No.6
DATE: AUGUST 10, & 11 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		HIGH PRESSURE WATER PUMP No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR 01	HYDROMONITOR 02	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	150±10	1034±69	160±20	1103±138	540	2.044	77	531	1.50	3.81	810	3.066	110	750	1.75	4.45	0	0.000	1.25	3.18	311.70±42.76	215.10±86.03	20250	76.7	1350	5.11
30	150±10	1034±69	160±20	1103±138	680	2.574	126	869	1.50	3.81	790	2.990	108	745	1.75	4.45	0	0.000	1.25	3.18	182.25±42.75	223.20±86.04	22050	83.5	1470	5.56
45	150±10	1034±69	160±20	1103±138	680	2.574	126	869	1.50	3.81	790	2.990	108	745	1.75	4.45	0	0.000	1.50	3.81	182.25±42.75	223.20±86.04	22050	83.5	1470	5.56
60	145±10	1000±69	160±20	1103±138	675	2.555	126	869	1.50	3.81	785	2.972	108	745	1.75	4.45	0	0.000	1.50	3.81	81.10±42.76	223.20±86.04	21900	82.9	1460	5.53
75	145±10	1000±69	160±20	1103±138	675	2.555	126	869	1.50	3.81	785	2.972	108	745	1.75	4.45	0	0.000	1.50	3.81	81.10±42.76	223.20±86.04	21900	82.9	1460	5.53
90	145±10	1000±69	160±20	1103±138	675	2.555	126	869	1.50	3.81	785	2.972	107	738	1.75	4.45	0	0.000	1.50	3.81	81.10±42.76	227.57±86.03	21900	82.9	1460	5.53
105	145±10	1000±69	160±20	1103±138	675	2.555	126	869	1.50	3.81	785	2.972	107	738	1.75	4.45	0	0.000	1.50	3.81	81.10±42.76	227.57±86.03	21900	82.9	1460	5.53
120	145±10	1000±69	155±20	1069±138	470	1.779	60	414	1.50	3.81	785	2.972	106	731	1.75	4.45	210	0.795	1.50	3.81	363.13±42.76	210.73±86.04	21975	83.2	1465	5.55
135	145±10	1000±69	155±20	1069±138	470	1.779	60	414	1.50	3.81	785	2.972	106	731	1.75	4.45	210	0.795	1.50	3.81	363.13±42.76	210.73±86.04	21975	83.2	1465	5.55
150	145±10	1000±69	155±20	1069±138	470	1.779	60	414	1.50	3.81	785	2.972	106	731	1.75	4.45	210	0.795	1.50	3.81	363.13±42.76	210.73±86.04	21975	83.2	1465	5.55
165	115± 5	793±34	170±20	1172±138	520	1.968	75	517	1.50	3.81	830	3.142	120	827	1.75	4.45	210	0.795	1.50	3.81	171.03±21.07	215.10±86.03	23400	88.6	1560	5.91
180	115± 5	793±34	170±20	1172±138	520	1.968	75	517	1.50	3.81	830	3.142	120	827	1.75	4.45	210	0.795	1.50	3.81	171.03±21.07	215.16±86.03	23400	88.6	1560	5.91
AVG.	141± 9	974±63	160±20	1106±138	588	2.224	97	668			795	3.011	110	755			88	0.331			189.36±39.14	210.79±86.04	22056	83.5	1470	5.57

TEST No.2, RUN No.7
DATE: AUGUST 11 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		WATER PUMP No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR 01	HYDROMONITOR 02	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
---	--- --	---- --	--- --	---- ---	---	-.---	----	----	-.--	-.--	---	-.---	---	----	-.--	-.--	---	-.---	-.--	-.--	---.-- --.--	---.-- --.--	-----	---.-	----	-.--
15	90±10	621±69	170±20	1172±130	465	1.760	60	414	1.50	3.01	825	3.123	118	814	1.75	4.45	260	0.984	1.25	3.18	120.27±42.76	223.20±86.04	23250	88.0	1550	5.87
30	90±10	621±69	170±20	1172±130	465	1.760	60	414	1.50	3.01	825	3.123	117	807	1.75	4.45	260	0.984	1.25	3.18	120.27±42.76	227.57±86.03	23250	88.0	1550	5.87
45	90±10	621±69	170±20	1172±130	465	1.760	60	414	1.50	3.01	825	3.123	117	807	1.75	4.45	260	0.984	1.25	3.18	120.27±42.76	227.57±86.03	23250	88.0	1550	5.87
60	90±10	621±69	170±20	1172±130	465	1.760	60	414	1.50	3.01	825	3.123	117	807	1.75	4.45	260	0.984	1.25	3.18	120.27±42.76	227.57±86.03	23250	88.0	1550	5.87
75	100±10	689±69	190±20	1310±130	595	2.252	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	260	0.984	1.25	3.18	12.39±42.76	223.82±86.04	26175	99.1	1745	6.61
90	100±10	689±69	190±20	1310±130	595	2.252	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	260	0.984	1.25	3.18	12.39±42.76	223.82±86.04	26175	99.1	1745	6.61
105	100±10	689±69	190±20	1310±130	595	2.252	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	260	0.984	1.25	3.18	12.39±42.76	223.82±86.04	26175	99.1	1745	6.61
120	100±10	689±69	190±20	1310±130	595	2.252	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	260	0.984	1.25	3.18	12.39±42.76	223.82±86.04	26175	99.1	1745	6.61
135	100±10	689±69	190±20	1310±130	590	2.233	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	270	1.022	1.25	3.18	12.39±42.76	223.82±86.04	26250	99.4	1750	6.62
150	100±10	689±69	190±20	1310±130	590	2.233	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	270	1.022	1.25	3.18	12.39±42.76	223.82±86.04	26250	99.4	1750	6.62
165	100±10	689±69	190±20	1310±130	590	2.233	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	270	1.022	1.25	3.18	12.39±42.76	223.82±86.04	26250	99.4	1750	6.62
180	100±10	689±69	190±20	1310±130	590	2.233	97	669	1.50	3.01	890	3.369	138	951	1.75	4.45	270	1.022	1.25	3.18	12.39±42.76	223.82±86.04	26250	99.4	1750	6.62
AVG.	97±10	666±69	183±20	1264±130	550	2.082	85	584			868	3.287	131	904			263	0.997			51.02±42.76	224.71±86.04	25225	95.5	1682	6.37

TEST No.2, RUN No.8. (WITH ELBOW)

DATE: AUGUST 12 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		HIGH PRESSURE WATER PUMP No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR #1	HYDROMONITOR #2	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
10	100±10	689±69	160±20	1103±138	750	2.839	93	641	1.75	4.45	810	3.066	111	765	1.75	4.45	290	1.098	1.50	3.81	29.74±42.76	210.73±86.04	18500	70.0	1850	7.00
20	100±10	689±69	160±20	1103±138	750	2.839	93	641	1.75	4.45	810	3.066	111	765	1.75	4.45	290	1.098	1.50	3.81	29.74±42.76	210.73±86.04	18500	70.0	1850	7.00
30	100±10	689±69	160±20	1103±138	750	2.839	93	641	1.75	4.45	810	3.066	111	765	1.75	4.45	290	1.098	1.50	3.81	29.74±42.76	210.73±86.04	18500	70.0	1850	7.00
40	100±10	689±69	160±20	1103±138	750	2.839	93	641	1.75	4.45	810	3.066	111	765	1.75	4.45	290	1.098	1.50	3.81	29.74±42.76	210.73±86.04	18500	70.0	1850	7.00
AVG.	100±10	689±69	160±20	1103±138	750	2.839	93	641			810	3.066	111	765			290	1.098			29.74±42.76	210.73±86.04	18500	70.0	1850	7.00

TEST No.2, RUN No.8. (WITHOUT ELBOW)
DATE: AUGUST 12 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		HIGH PRESSURE WATER PUMP No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR 01	HYDROMONITOR 02	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
10	130±10	896± 69	62± 5	427± 34	870	3.293	120	827	1.75	4.45	400	1.514	0	0	3.00	7.62	200	0.757	1.50	3.81	42.76±42.76	266.22±21.20	14700	55.6	1470	5.56
20	130±10	896± 69	62± 5	427± 34	870	3.293	120	827	1.75	4.45	400	1.514	0	0	3.00	7.62	200	0.757	1.50	3.81	42.76±42.76	266.22±21.20	14700	55.6	1470	5.56
30	130±10	896± 69	62± 5	427± 34	870	3.293	120	827	1.75	4.45	400	1.514	0	0	3.00	7.62	200	0.757	1.50	3.81	42.76±42.76	266.22±21.20	14700	55.6	1470	5.56
40	130±10	896± 69	62± 5	427± 34	870	3.293	120	827	1.75	4.45	400	1.514	0	0	3.00	7.62	200	0.757	1.50	3.81	42.76±42.76	266.22±21.20	14700	55.6	1470	5.56
50	130±10	896± 69	62± 5	427± 34	870	3.293	120	827	1.75	4.45	400	1.514	0	0	3.00	7.62	200	0.757	1.50	3.81	42.76±42.76	266.22±21.20	14700	55.6	1470	5.56
60	130±10	896± 69	62± 5	427± 34	870	3.293	120	827	1.75	4.45	400	1.514	0	0	3.00	7.62	200	0.757	1.50	3.81	42.76±42.76	266.22±21.20	14700	55.6	1470	5.56
70	210±20	1448±138	0± 0	0± 0	450	1.703	27	186	1.75	4.45	0	0.000	0	0	3.00	7.62	250	0.946	1.50	3.81	782.03±85.52	0.00± 0.00	7000	26.5	700	2.65
80	210±20	1448±138	0± 0	0± 0	450	1.703	27	186	1.75	4.45	0	0.000	0	0	3.00	7.62	0	0.000	1.50	3.81	782.03±85.52	0.00± 0.00	4500	17.0	450	1.70
AVG.	150±13	1034± 86	47± 4	320± 26	765	2.896	97	667			300	1.136	0	0			181	0.686			227.58±53.45	199.67±15.90	12463	47.1	1246	4.71

SPECIAL RUN No.1
DATE: AUGUST 7 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR 01	HYDROMONITOR 02	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	130±10	896±69	180±10	1241± 69	600	2.271	130	896	1.25	3.18	750	2.839	167	1151	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	56.11±43.02	20250	76.7	1350	5.11
30	130±10	896±69	180±10	1241± 69	600	2.271	130	896	1.25	3.18	700	2.650	145	1000	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	150.26±43.01	19500	73.0	1300	4.92
45	130±10	896±69	180±10	1241± 69	600	2.271	130	896	1.25	3.10	700	2.650	145	1000	1.50	3.81	0	0.000	0.00	0.00	0.00±42.76	150.26±43.01	19500	73.0	1300	4.92
60	130±10	896±69	60± 0	414± 0	590	2.233	110	758	1.25	3.18	590	2.233	5	34	3.00	7.62	0	0.000	0.00	0.00	85.52±42.75	236.92± 0.00	17700	67.0	1180	4.47
75	110±10	758±69	60± 0	414± 0	400	1.017	100	689	1.25	3.10	400	1.514	0	0	3.00	7.62	0	0.000	0.00	0.00	42.76±42.76	258.12± 0.00	13200	50.0	880	3.33
90	110±10	758±69	60± 0	414± 0	400	1.017	100	689	1.25	3.10	400	1.514	0	0	3.00	7.62	0	0.000	0.00	0.00	42.76±42.76	258.12± 0.00	13200	50.0	880	3.33
105	110±10	758±69	60± 0	414± 0	400	1.017	100	689	1.25	3.10	400	1.514	0	0	3.00	7.62	0	0.000	0.00	0.00	42.76±42.76	258.12± 0.00	13200	50.0	880	3.33
120	110±10	758±69	60± 0	414± 0	400	1.017	100	689	1.25	3.10	400	1.514	0	0	3.00	7.62	0	0.000	0.00	0.00	42.76±42.76	258.12± 0.00	13200	50.0	880	3.33
AVG.	120±10	827±69	105± 4	724± 26	539	2.039	113	775			543	2.054	50	398			0	0.000			32.07±42.76	203.25±16.13	16219	61.4	1001	4.09

SPECIAL RUN No.2
DATE: AUGUST 8 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

TIME	HIGH PRESSURE WATER PUMP NO.01 DISCHARGE PRESSURE		HIGH PRESSURE WATER PUMP No.02 DISCHARGE PRESSURE		HYDROMONITOR No.01 FLOW RATE		HYDROMONITOR No.01 DISCHARGE PRESSURE		HYDROMONITOR No.01 SIZE OF NOZZLE		HYDROMONITOR No.02 FLOW RATE		HYDROMONITOR No.02 DISCHARGE PRESSURE		HYDROMONITOR No.02 SIZE OF NOZZLE		HYDROMONITOR No.03 FLOW RATE		HYDROMONITOR No.03 SIZE OF NOZZLE		PRESSURE DROP IN PIPELINE HYDROMONITOR #1	PRESSURE DROP IN PIPELINE HYDROMONITOR #2	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	120± 5	827±34	190±10	1310± 69	370	1.401	78	538	1.25	3.18	930	3.520	152	1048	1.75	4.45	0	0.000	1.25	3.18	179.09±21.07	163.35±43.02	19500	73.8	1300	4.92
30	120± 5	827±34	190±10	1310± 69	370	1.401	78	538	1.25	3.18	930	3.520	152	1048	1.75	4.45	0	0.000	1.25	3.18	179.09±21.07	163.35±43.02	19500	73.8	1300	4.92
45	130±10	896±69	190±20	1310±130	490	1.855	135	931	1.25	3.18	910	3.445	146	1007	1.75	4.45	410	1.552	1.25	3.18	-21.69±42.76	100.91±86.04	27150	102.8	1810	6.85
60	130±10	896±69	190±20	1310±130	490	1.855	135	931	1.25	3.18	910	3.445	146	1007	1.75	4.45	410	1.552	1.25	3.18	-21.69±42.76	100.91±86.04	27150	102.8	1810	6.85
75	130±10	896±69	190±20	1310±130	490	1.855	135	931	1.25	3.18	910	3.445	147	1014	1.75	4.45	410	1.552	1.25	3.18	-21.69±42.76	104.55±86.03	27150	102.8	1810	6.85
90	130±10	896±69	190±20	1310±130	490	1.855	135	931	1.25	3.18	910	3.445	147	1014	1.75	4.45	410	1.552	1.25	3.18	-21.69±42.76	104.55±86.03	27150	102.8	1810	6.85
105	130±10	896±69	190±20	1310±130	490	1.855	134	924	1.25	3.18	910	3.445	147	1014	1.75	4.45	410	1.552	1.25	3.18	-17.35±42.76	104.55±86.03	27150	102.8	1810	6.85
AVG.	127±10	876±69	190±20	1310±130	456	1.725	119	818			916	3.466	148	1022			293	1.109			36.30±42.76	179.74±86.03	24964	94.5	1664	6.30

PRELIMINARY RUN
DATE: JULY 24 1986

TEST DATA: WATER SUPPLY PUMP/PIPELINE SYSTEM

	HIGH PRESSURE WATER PUMP NO.01		HIGH PRESSURE WATER PUMP No.02		HYDROMONITOR No.01						HYDROMONITOR No.02						HYDROMONITOR No.03				PRESSURE DROP IN PIPELINE					
TIME	DISCHARGE PRESSURE		DISCHARGE PRESSURE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		DISCHARGE PRESSURE		SIZE OF NOZZLE		FLOW RATE		SIZE OF NOZZLE		HYDROMONITOR #1	HYDROMONITOR #2	TOTAL FLOW		TOTAL FLOW RATE	
	psi	Kpa	psi	Kpa	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	psi	Kpa	inch	cm	GPM	m^3PM	inch	cm	m/100m	m/100m	GAL	m^3	GPM	m^3PM
15	185±10	1276±69	0± 0	0± 0	550	2.082	185	1276	1.25	3.18	0	0.000	0	0	0.00	0.00	0	0.000	0.00	0.00	0.00±42.76	0.00± 0.00	0250	31.2	550	2.00
30	185±10	1276±69	0± 0	0± 0	550	2.082	185	1276	1.25	3.18	0	0.000	0	0	0.00	0.00	0	0.000	0.00	0.00	0.00±42.76	0.00± 0.00	0250	31.2	550	2.00
45	185±10	1276±69	0± 0	0± 0	550	2.082	185	1276	1.25	3.18	0	0.000	0	0	0.00	0.00	0	0.000	0.00	0.00	0.00±42.76	0.00± 0.00	0250	31.2	550	2.00
60	185±10	1276±69	0± 0	0± 0	550	2.082	185	1276	1.25	3.18	0	0.000	0	0	0.00	0.00	0	0.000	0.00	0.00	0.00±42.76	0.00± 0.00	0250	31.2	550	2.00
AVG.	185±10	1276±69	0± 0	0± 0	550	2.082	185	1276			0	0.000	0	0			0	0.000			0.00±42.76	0.00± 0.00	0250	31.2	550	2.00

APPENDIX C

PUMP PERFORMANCE CALCULATIONS

Sample Calculation 3: Using the equations presented above, pump efficiency was calculated as follows for the 800 rpm, 0.5 inch configuration (Test 1):

$$\text{Eff.\%} = \frac{(\ P)(Q)}{BHP} \times 100\%$$

$$\text{Eff.\%} = \frac{(85.7991 - 0.26511Q - 0.256845(S))\ (Q)\ (9.81)}{(60 \times 0.7457 \times 264.17)(219.208 + 0.000033Q + 1.18982(S))} \times 100\%$$

Valid in the range 1600 Q 2650

Sample Calculation 4: Peat slurry flow rate versus total hydromonitor flow rate versus slurry concentration.

From field data, all runs.

$yixisi = 551196010.8$
$xi^2\ si = 770386840.9$
$xi = 319610544$ Not including data where y x
$xi^2\ si^2 = 2140982061$
$xiyi = 230950231$

From Eq. #1

$B = -0.01930903303$

From Eq. #2

$m = 0.7691412584$

Equation equals

$y = (0.7691413 - 0.019309(S))\ x$

Where y = total hydromonitor flow rate (GPM)
s = solids content
x = peat slurry flow rate

$y = 0.7401778\ x$ for 1.5% solids
$y = 0.7208688\ x$ for 2.5% solids
$y = 0.7015598\ x$ for 3.5% solids

C.2 PUMP PERFORMANCE CURVES

Figures C-1 and C-2 give pump performance curves based on the relationships derived in Section B.1, for 3.5% solids - this solids concentration was chosen to compare results to the earlier 1985 test results which had an average solids concentration of 3.7%.

C.1 LINEAR REGRESSION RELATIONSHIPS OF PUMP PERFORMANCE

In Section 5.3.2, the pump performance curves were developed for selected ranges of solids contents. Further regression analyses were carried out, incorporating solids concentration as a variable, to display the pump performance results in the most useful manner for further design calculations. Sample calculations follow:

Sample Calculation 1: Q-H versus S (solids concentration)

800 rpm, 0.50" clr., from field data, runs no. 1, 2, 3, and 4.

yi = 647.39
xisi = 147952.42
xi = 68087
si = 261.126
xiyi = 865786.48
xi = 106290511
si = 98.26
yisi = 1252.846

n = 47 (Note: Data not used was run no. 1 at 90, 105, 120 minutes and run no. 3 at 195 minutes.)

$H = 28.3648 - 0.0087337Q - 0.92713(S)$
Valid in range 900 Q 2000

Where H = head (m)
Q = flow rate (GPM)
S = solids content (%)

Sample Calculation 2: For 800 rpm and 0.5 inch clearance, brake horsepower was analysed in a similar fashion and the following relationship was established.

For 800 rpm, 0.50" clr.

$H = 28.3648 - 0.0087337Q - 0.92713(S)$
Valid in range 900 Q 2000

Where H = head (m)
Q = flow rate (GPM)
S = solids content (%)

$BHP = 86.5422 + 0.007681Q + 0.18044S$
Valid in the range 900 Q 2000

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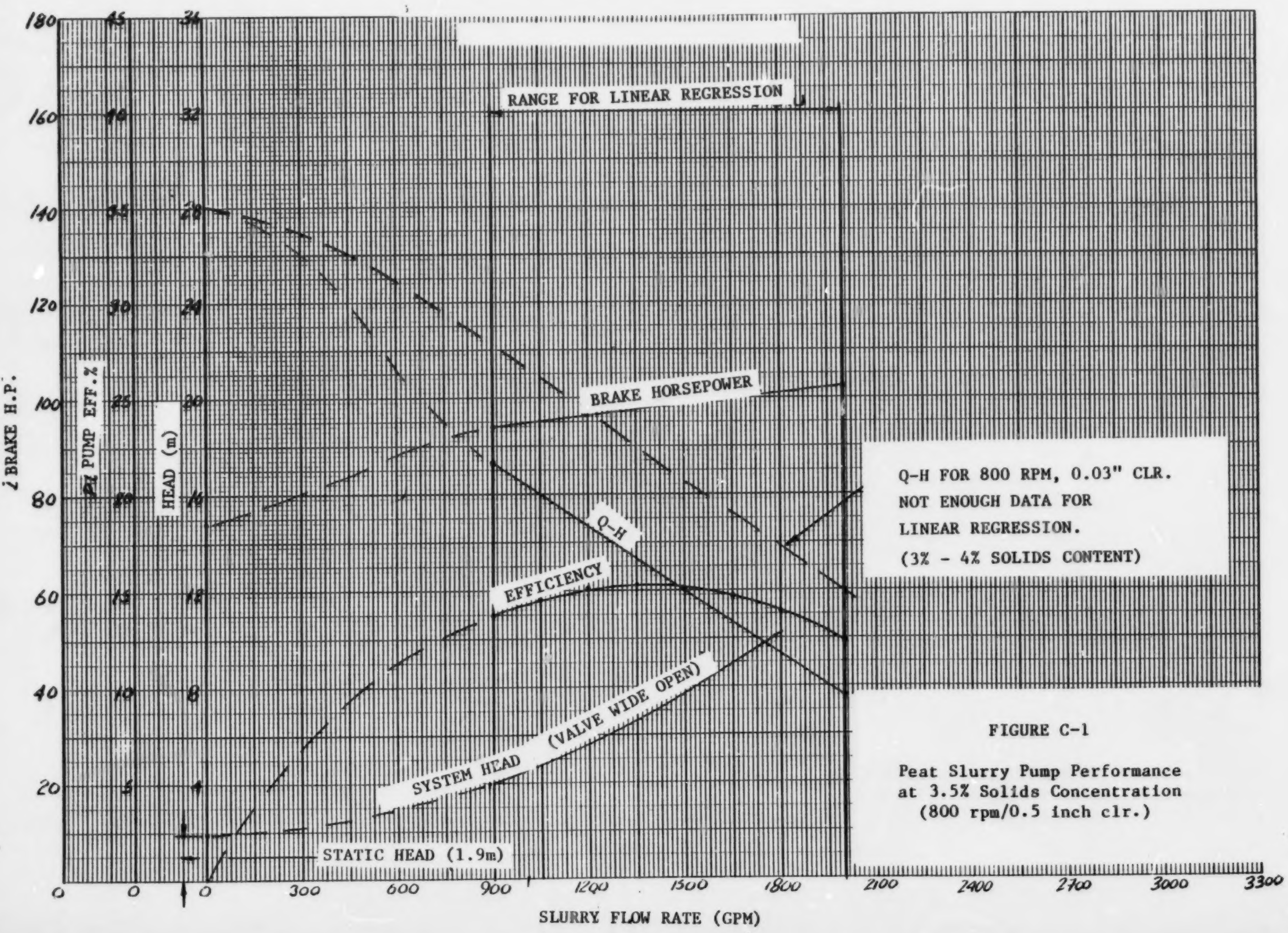

FIGURE C-1

Peat Slurry Pump Performance
at 3.5% Solids Concentration
(800 rpm/0.5 inch clr.)

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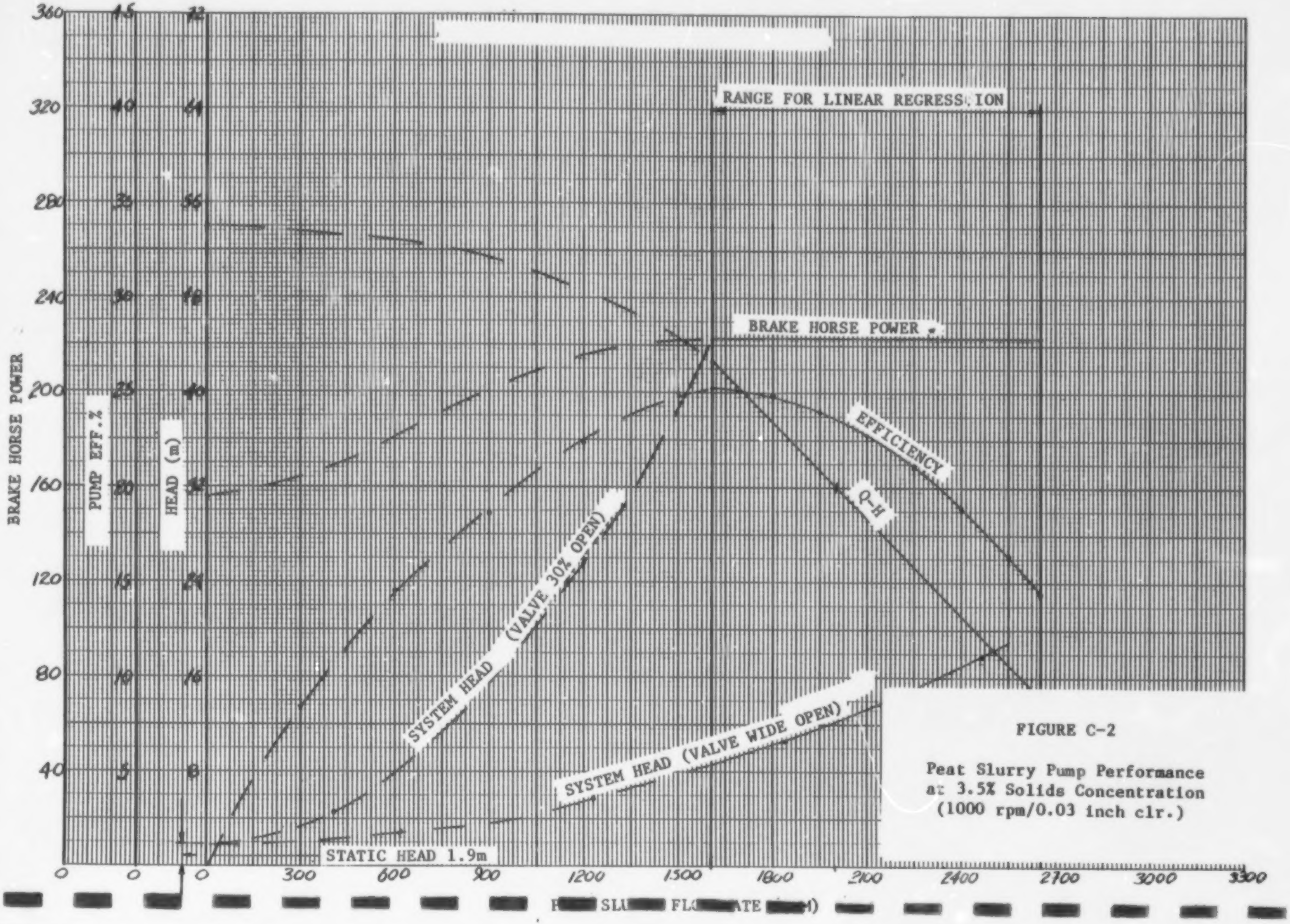


FIGURE C-2

Peat Slurry Pump Performance
at 3.5% Solids Concentration
(1000 rpm/0.03 inch clr.)

APPENDIX D

FRICTION LOSS, CRITICAL LENGTH CALCULATIONS

Critical Length Illustration Test
1000 RPM/0.03 in Clearance Pump

k1=	53.00972	ep=	0.05	mm
k2=	-0.00014	kvis	0.000001	m^2/s
k3=	-0.00000			

Length	Qest	Vest	a	b	c	f	Re	k4	Q	Qest	Diff
500	0.414	6.267790	0.014060	1.943454	0.507242	0.015359	1817659.	0.618731	0.413943	0.414	-0.00005
1000	0.29	4.390481	0.014060	1.943454	0.507242	0.015616	1273239.	0.629083	0.290284	0.29	0.000284
1500	0.236	3.572943	0.014060	1.943454	0.507242	0.015787	1036153.	0.635988	0.235725	0.236	-0.00027
2000	0.203	3.073336	0.014060	1.943454	0.507242	0.015924	891267.6	0.641511	0.203263	0.203	0.000263
2500	0.181	2.740265	0.014060	1.943454	0.507242	0.016036	794677.0	0.646010	0.181170	0.181	0.000170
3000	0.165	2.498032	0.014060	1.943454	0.507242	0.016131	724429.3	0.649836	0.164897	0.165	-0.00010
3500	0.152	2.301217	0.014060	1.943454	0.507242	0.016219	667353.1	0.653382	0.152250	0.152	0.000250
4000	0.142	2.149821	0.014060	1.943454	0.507242	0.016295	623448.3	0.656436	0.142085	0.142	0.000085
4500	0.134	2.028705	0.014060	1.943454	0.507242	0.016361	588324.4	0.659123	0.133686	0.134	-0.00031
5000	0.1265	1.915158	0.014060	1.943454	0.507242	0.016430	555395.8	0.661872	0.126562	0.1265	0.000062
5500	0.1205	1.824320	0.014060	1.943454	0.507242	0.016489	529052.9	0.664254	0.120456	0.1205	-0.00004
6000	0.115	1.741052	0.014060	1.943454	0.507242	0.016547	504905.3	0.666600	0.115124	0.115	0.000124
7000	0.106	1.604796	0.014060	1.943454	0.507242	0.016652	465391.0	0.670828	0.106248	0.106	0.000248
10000	0.088	1.332283	0.014060	1.943454	0.507242	0.016909	386362.3	0.681165	0.088216	0.088	0.000216

Date	Test Number	Run Number	Time (min)	Flow Rate (m^3/s)	Pump Submer. (m)	Specific Gravity	Static Head (m)	Loss per Meter 4-5	5-6	6-7	7-8	8-9	Avg. Loss/M
86-07-24	800 Rpm 0.5 in. clr.	Prelim.	15	0.149	0.73	1.001	1.8	0.0244	0.0116	0.0192	0.0169	0.0152	0.0175
			30	0.125	0.73	1.007	1.8	0.0110	0.0148	0.0133	0.0095	0.0151	0.0127
			45	0.129	0.73	1.009	1.8	0.0191	0.0115	0.0132	0.0168	0.0119	0.0145
			60	0.129	0.73	1.006	1.8	0.0141	0.0171	0.0133	0.0168	0.0135	0.0150
86-07-26	800 RPM 0.5 in. clr.	1	15	0.091	0.8	1.030	1.87	0.0088	0.0113	0.0072	0.0118	0.0040	0.0086
			45	0.086	0.8	1.004	1.87	0.0060	0.0094	0.0063	0.0119	0.0025	0.0072
			60	0.086	0.8	1.013	1.87	0.0059	0.0093	0.0085	0.0070	0.0025	0.0067
			90	0.080	0.83	1.018	1.9	0.0069	0.0060	0.0050	0.0118	-0.0006	0.0058
			105	0.074	0.83	1.016	1.9	0.0029	0.0093	0.0050	0.0119	0.0033	0.0065
			120	0.045	0.83	1.016	1.9	0.0079	0.0038	0.0038	0.0046	-0.0006	0.0039
86-07-28			135	0.086	0.77	1.014	1.84	0.0039	0.0060	0.0027	0.0094	0.0025	0.0049
			150	0.086	0.77	1.004	1.84	0.0040	0.0116	0.0051	0.0119	0.0025	0.0070
			165	0.086	0.77	1.008	1.84	0.0040	0.0115	0.0051	0.0095	0.0009	0.0062
			180	0.077	0.77	1.009	1.84	0.0060	0.0071	0.0016	0.0095	0.0025	0.0053
86-07-28		2	15	0.057	0.75	1.010	1.82	0.0019	0.0038	0.0004	0.0095	0.0025	0.0036
			30	0.057	0.75	1.008	1.82	0.0024	0.0027	0.0004	0.0095	0.0025	0.0035
			45	0.057	0.75	1.010	1.82	0.0019	0.0049	0.0004	0.0095	0.0041	0.0042
			60	0.060	0.78	1.006	1.85	0.0009	0.0049	0.0004	0.0119	0.0025	0.0041
			75	0.057	0.78	1.010	1.85	0.0014	0.0049	0.0004	0.0095	0.0025	0.0037
			90	0.057	0.78	1.011	1.85	0.0024	0.0038	-0.0008	0.0119	0.0025	0.0040
			105	0.057	0.78	1.008	1.85	0.0014	0.0049	0.0004	0.0095	0.0041	0.0041
			120	0.057	0.78	1.009	1.85	0.0019	0.0049	0.0004	0.0070	0.0041	0.0037
			135	0.057	0.8	1.006	1.87	0.0019	0.0038	0.0004	0.0095	0.0025	0.0036
			150	0.063	0.8	1.012	1.87	0.0019	0.0049	0.0004	0.0095	0.0041	0.0042
			165	0.057	0.87	1.005	1.94	0.0025	0.0050	0.0004	0.0095	0.0041	0.0043
			180	0.057	0.87	1.006	1.94	0.0030	0.0038	0.0039	0.0070	0.0010	0.0037
86-07-28		3	15	0.143	0.96	1.011	2.03	0.0150	0.0203	0.0132	0.0192	0.0103	0.0156
			30	0.137	0.96	1.015	2.03	0.0140	0.0158	0.0131	0.0119	0.0119	0.0133
			45	0.135	1.1	1.017	2.17	0.0149	0.0147	0.0142	0.0094	0.0087	0.0124
			75	0.145	1.1	1.024	2.17	0.0168	0.0189	0.0130	0.0166	0.0117	0.0154
			90	0.101	1	1.017	2.07	0.0089	0.0147	0.0108	0.0119	0.0087	0.0110
			105	0.095	1	1.019	2.07	0.0109	0.0147	0.0096	0.0118	0.0103	0.0115
			120	0.097	1	1.030	2.07	0.0098	0.0102	0.0106	0.0118	0.0101	0.0105
			135	0.095	1.05	1.028	2.12	0.0048	0.0135	0.0129	0.0070	0.0102	0.0097
			150	0.087	1.05	1.032	2.12	0.0068	0.0059	0.0151	0.0046	0.0070	0.0079
			165	0.107	1.05	1.019	[illegible]	0.0129	0.0114	0.0131	0.0118	0.0103	0.0119
			180	0.099	1.05	1.022	[illegible]	0.0089	0.0125	0.0107	0.0094	0.0071	0.0097
			195	0.083	1.06	1.030	[illegible]	0.0068	0.0059	0.0083	0.0094	0.0086	0.0078
			210	0.105	1.06	1.019	[illegible]	0.0139	0.0103	0.0096	0.0118	0.0118	0.0115
86-08-01		4	15	0.117	1.2	1.017	[illegible]	0.0149	0.0158	0.0131	0.0167	0.0134	0.0148
			30	0.119	1.26	[illegible]	[illegible]	0.0110	0.0170	0.0120	-0.0027	0.0197	0.0114
			45	0.115	1.37	1.015	2.44	0.0150	0.0158	0.0143	0.0119	0.0134	0.0141
			60	0.111	1.4	1.018	[illegible]	0.0140	0.0180	0.0096	0.0046	0.0165	0.0125
			75	0.109	1.45	1.024	[illegible]	0.0089	0.0168	0.0118	0.0094	0.0148	0.0123
			90	0.105	1.5	1.030	2.57	0.0108	0.0199	0.0106	0.0046	0.0132	0.0118
			120	0.115	1.35	1.021	2.42	0.0159	0.0168	0.0130	0.0094	0.0149	0.0140
			150	0.101	1.25	1.013	2.37	0.0090	0.0126	0.0097	0.0022	0.0150	0.0097
			165	0.115	1.27	1.021	2.34	0.0109	0.0168	0.0130	0.0070	0.0149	0.0125
			180	0.107	1.29	1.016	2.36	0.0099	0.0158	0.0131	0.0070	0.0165	0.0125
			195	0.099	1.29	1.008	2.36	0.0120	0.0115	0.0109	0.0070	0.0151	0.0113
			210	0.101	1.35	1.023	2.42	0.0119	0.0114	0.0095	0.0094	0.0149	0.0114

86-08-07	800 RPM	Special-1	15	0.145	0.45	1.015	1.52	0.0240	0.0202	0.0178	0.0240	0.0259	0.0224
	0.03 in. clr.		30	0.137	0.45	1.016	1.52	0.0230	0.0202	0.0166	0.0240	0.0243	0.0216
			45	0.121	0.5	1.009	1.57	0.0090	0.0159	0.0249	0.0168	0.0182	0.0170
			60	0.135	0.5	1.019	1.57	0.0139	0.0256	0.0211	0.0191	0.0196	0.0199
			75	0.121	0.5	1.036	1.57	0.0078	0.0144	0.0230	0.0165	0.0177	0.0159
			90	0.111	0.62	1.022	1.69	0.0039	0.0146	0.0234	0.0142	0.0180	0.0148
			105	0.129	0.62	1.032	1.69	0.0137	0.0166	0.0197	0.0213	0.0209	0.0184
			120	0.129	0.62	1.026	1.69	0.0138	0.0167	0.0198	0.0214	0.0210	0.0185
86-08-08		Special-2	15	0.159	0.6	1.020	1.67	0.0259	0.0255	0.0234	0.0263	0.0211	0.0245
			30	0.153	0.6	1.033	1.67	0.0236	0.0220	0.0265	0.0260	0.0162	0.0229
			45	0.135	0.6	1.028	1.67	0.0237	0.0199	0.0060	0.0238	0.0148	0.0176
			60	0.135	0.8	1.024	1.87	0.0188	0.0179	0.0268	0.0094	0.0148	0.0175
			75	0.101	0.8	1.022	1.87	0.0159	0.0201	0.0107	0.0166	0.0056	0.0138
			90	0.125	0.73	1.017	1.8	0.0139	0.0114	0.0247	0.0167	0.0165	0.0166
			105	0.129	0.75	1.015	1.82	0.0240	0.0202	0.0062	0.0240	0.0181	0.0185
86-08-10	1000 RPM	5	15	0.191	0.65	1.020	1.72	0.0319	0.0386	0.0534	0.0408	0.0304	0.0390
	0.03 in. clr.		30	0.151	0.65	1.017	1.72	0.0240	0.0441	0.0305	-0.0196	0.0305	0.0219
			45	0.153	0.7	1.019	1.77	0.0439	0.0114	0.0246	0.0288	0.0227	0.0263
			60	0.153	0.7	1.013	1.77	0.0190	0.0388	0.0248	0.0289	0.0228	0.0269
			75	0.141	0.8	1.031	1.87	0.0335	0.0167	0.0163	0.0213	0.0224	0.0220
			90	0.157	0.8	1.027	1.87	0.0009	0.0599	0.0301	0.0286	0.0225	0.0284
			105	0.143	0.8	1.027	1.87	0.0237	0.0275	0.0129	0.0166	0.0302	0.0222
			120	0.139	0.7	1.027	1.77	0.0257	0.0167	0.0072	0.0406	0.0302	0.0241
			135	0.165	0.7	1.024	1.77	0.0387	0.0222	0.0417	0.0238	0.0179	0.0289
			150	0.181	0.73	1.028	1.8	0.0336	0.0437	0.0473	0.0285	0.0302	0.0366
			165	0.157	0.73	1.018	1.8	0.0289	0.0386	0.0131	0.0409	0.0227	0.0288
			180	0.147	0.77	1.022	1.84	0.0418	0.0276	0.0188	0.0215	0.0118	0.0243
			195	0.145	0.85	1.021	1.92	0.0289	0.0136	0.0280	0.0166	0.0180	0.0210
86-08-10	1000 RPM	6	15	0.127	0.8	1.017	1.87	0.0119	0.0169	0.0166	0.0167	0.0149	0.0154
	0.03 in. clr.		30	0.127	0.8	1.028	1.87	0.0098	0.0275	0.0152	0.0118	0.0148	0.0158
			45	0.127	0.8	1.021	1.87	0.0139	0.0190	0.0153	0.0215	0.0164	0.0172
			60	0.125	0.81	1.030	1.88	0.0137	0.0167	0.0174	0.0165	0.0163	0.0161
			75	0.123	0.81	1.032	1.88	0.0108	0.0166	0.0163	0.0165	0.0147	0.0150
			90	0.129	0.85	1.027	1.92	0.0158	0.0167	0.0187	0.0190	0.0133	0.0167
			105	0.127	0.85	1.020	1.92	0.0119	0.0168	0.0211	0.0167	0.0149	0.0163
			120	0.127	0.85	1.026	1.92	0.0108	0.0200	0.0175	0.0190	0.0148	0.0164
			135	0.121	0.92	1.026	1.99	0.0088	0.0178	0.0175	0.0166	0.0148	0.0151
			150	0.115	0.92	1.015	1.99	0.0110	0.0202	0.0154	0.0119	0.0103	0.0137
			165	0.129	0.8	1.021	1.87	0.0159	0.0201	0.0188	0.0191	0.0164	0.0180
			180	0.121	0.86	1.019	1.93	0.0179	0.0169	0.0165	0.0263	0.0118	0.0179
86-08-11		7	15	0.107	0.93	1.017	2	0.0079	0.0125	0.0131	0.0143	0.0087	0.0113
			30	0.105	0.92	1.024	1.99	0.0057	0.0114	0.0141	0.0142	0.0102	0.0112
			45	0.105	0.97	1.020	2.04	0.0089	0.0103	0.0142	0.0142	0.0102	0.0116
			60	0.111	0.97	1.020	2.04	0.0089	0.0114	0.0130	0.0167	0.0071	0.0114
			75	0.105	0.9	1.015	1.97	0.0089	0.0136	0.0131	0.0167	0.0103	0.0125
			90	0.101	0.92	1.015	1.99	0.0089	0.0126	0.0143	0.0167	0.0103	0.0126
			105	0.105	0.92	1.021	1.99	0.0099	0.0125	0.0142	0.0142	0.0087	0.0119
			120	0.101	0.91	1.024	1.98	0.0089	0.0124	0.0141	0.0142	0.0117	0.0123
			135	0.101	0.9	1.026	1.97	0.0068	0.0135	0.0141	0.0142	0.0086	0.0115
			150	0.105	0.88	1.021	1.95	0.0079	0.0136	0.0153	0.0142	0.0102	0.0122
			165	0.101	0.88	1.019	1.95	0.0089	0.0114	0.0131	0.0143	0.0087	0.0113
			180	0.097	0.87	1.015	1.94	0.0039	0.0115	0.0143	0.0143	0.0072	0.0102
86-08-12		8	10	0.236	0.67	1.008	1.74	0.0646	0.0890	0.0340	0.0760	0.2964	0.1120
			20	0.227	0.67	1.004	1.74	0.0578	0.0853	0.0414	0.0726	0.2268	0.0968

	30	0.179	0.9	1.010	1.97	0.0322	0.0623	0.0269	0.0504	0.2019	0.0747
	40	0.153	0.9	1.015	1.97	0.0441	0.0620	0.0102	0.0393	0.1775	0.0666
	50	0.119	0.72	1.009	1.79	0.0120	0.0235	0.0103	0.0239		0.0174
	60	0.117	0.72	1.009	1.79	0.0120	0.0194	0.0103	0.0239		0.0164
	70	0.119	0.81	1.011	1.88	0.0140	0.0194	0.0126	0.0239		0.0175
	80	0.121	0.81	1.008	1.88	0.0141	0.0235	0.0103	0.0289		0.0192
	90	0.119	0.91	1.012	1.98	0.0140	0.0234	0.0102	0.0239		0.0179
	100	0.117	0.91	1.013	1.98	0.0130	0.0193	0.0126	0.0288		0.0184
	110	0.119	1.02	1.016	2.09	0.0150	0.0213	0.0078	0.0287		0.0182
	120	0.121	1.3	1.012	2.37	0.0160	0.0194	0.0079	0.0288		0.0180
86-08-07 800 RPM Water Tes	15	0.185	0.42	1.000	1.49	0.0346	0.0404	0.0246	0.0452	0.0358	0.0361
0.03 in. clr.	30	0.185	0.42	1.000	1.49	0.0346	0.0404	0.0287	0.0366	0.0358	0.0352
	45	0.191	0.42	1.000	1.49	0.0387	0.0349	0.0369	0.0366	0.0342	0.0363
	60	0.189	0.42	1.000	1.49	0.0387	0.0360	0.0346	0.0366	0.0310	0.0354
86-08-10 1000 RPM	15	0.238	0.65	1.000	1.72	0.0560	0.0194	0.1134	0.0661	0.0587	0.0627
0.03 in. clr.	30	0.238	0.65	1.000	1.72	0.0580	0.0172	0.1134	0.0661	0.0587	0.0627
	45	0.238	0.65	1.000	1.72	0.0580	0.0172	0.1134	0.0661	0.0587	0.0627
	60	0.238	0.65	1.000	1.72	0.0590	0.0172	0.1111	0.0661	0.0587	0.0624
	75	0.238	0.65	1.000	1.72	0.0601	0.0149	0.1193	0.0538	0.0587	0.0614
	90	0.238	0.65	1.000	1.72	0.0774	0.0005	0.1146	0.0588	0.0540	0.0611
86-08-13 1000 RPM	10	0.225	0.9	1.000	1.97	0.0621	0.0897	0.0368	0.0728	0.2989	0.1121
0.03 in. clr.	20	0.225	0.9	1.000	1.97	0.0611	0.0918	0.0368	0.0728	0.3226	0.1170
	30	0.127	0.72	1.000	1.79	0.0172	0.0237	0.0152	0.0290		0.0213
	40	0.125	0.72	1.000	1.79	0.0172	0.0196	0.0152	0.0290		0.0203
	50	0.125	0.72	1.000	1.79	0.0162	0.0196	0.0152	0.0290		0.0200
86-08-13 1000 RPM	15	0.217	0.5	1.000	1.57	0.0366	0.0547	0.0296	0.0587		0.0449
0.03 in. clr.	30	0.246	0.6	1.000	1.62	0.0570	0.0732	0.0464	0.0785		0.0638
	45	0.246	0.55	1.000	1.62	0.0580	0.0732	0.0440	0.0785		0.0634
	60	0.244	0.55	1.000	1.62	0.0580	0.0712	0.0464	0.0785		0.0635
	75	0.227	0.55	1.000	1.62	0.0488	0.0691	0.0392	0.0686		0.0564
	90	0.227	0.56	1.000	1.63	0.0478	0.0670	0.0392	0.0736		0.0569
	105	0.209	0.55	1.000	1.62	0.0417	0.0526	0.0308	0.0637		0.0472
	120	0.211	0.53	1.000	1.6	0.0422	0.0526	0.0332	0.0612		0.0473
	135	0.258	0.53	1.000	1.6	0.0723	0.0928	0.0571	0.1008		0.0808
	150	0.258	0.57	1.000	1.64	0.0733	0.0918	0.0559	0.1032		0.0811
	165	0.252	0.55	1.000	1.62	0.0641	0.0774	0.0475	0.0834		0.0681
	180	0.252	0.55	1.000	1.62	0.0641	0.0774	0.0475	0.0834		0.0681

Date	Test Number	Run Number	Time (min)	Flow Rate (m^3/s)	Pump Submer. (m)	Friction Factor						Average f	Equiv. Length (m)	Kinematic Viscosity (m^2/s)	Vel (m/s)
						4-9	4-5	5-6	6-7	7-8	8-9				
86-07-24	800 Rpm 0.5 in. clr.	Prelim.	15	0.149	0.73	0.0199	0.0272	0.0130	0.0215	0.0189	0.0170	0.019526	638	2.40E-05	2.26
			30	0.125	0.73	0.0207	0.0176	0.0237	0.0211	0.0151	0.0241	0.020308	775	5.46E-06	1.89
			45	0.129	0.73	0.0217	0.0286	0.0172	0.0198	0.0251	0.0178	0.021703	639	5.95E-06	1.95
			60	0.129	0.73	0.0222	0.0211	0.0255	0.0199	0.0252	0.0202	0.022371	665	6.96E-06	1.95
86-07-26	800 RPM 0.5 in. clr.	1	15	0.091	0.8	0.0255	0.0263	0.0337	0.0214	0.0351	0.0119	0.025668	1255	1.65E-04	1.38
			45	0.086	0.8	0.0235	0.0204	0.0318	0.0213	0.0405	0.0086	0.024506	1664	1.84E-05	1.30
			60	0.086	0.8	0.0233	0.0202	0.0315	0.0289	0.0238	0.0085	0.022562	1657	2.17E-05	1.30
			90	0.080	0.83	0.0216	0.0270	0.0234	0.0194	0.0463	-0.0024	0.022728	1724	4.13E-05	1.21
			105	0.074	0.83	0.0260	0.0132	0.0419	0.0226	0.0536	0.0148	0.029224	1557	4.43E-05	1.12
			120	0.045	0.83	0.0507	0.0951	0.0457	0.0460	0.0550	-0.0074	0.046885	1725	2.95E-05	0.69
86-07-28			135	0.086	0.77	0.0153	0.0133	0.0204	0.0091	0.0320	0.0085	0.016663	3517	1.18E-05	1.30
			150	0.086	0.77	0.0226	0.0135	0.0393	0.0173	0.0405	0.0086	0.023830	2018	1.29E-05	1.30
			165	0.086	0.77	0.0207	0.0134	0.0391	0.0172	0.0321	0.0032	0.021012	2230	7.44E-06	1.30
			180	0.077	0.77	0.0212	0.0251	0.0299	0.0065	0.0397	0.0106	0.022370	2993	6.94E-06	1.16
86-07-28		2	15	0.057	0.75	0.0225	0.0147	0.0293	0.0030	0.0724	0.0192	0.027728	4828	5.45E-06	0.86
			30	0.057	0.75	0.0216	0.0187	0.0210	0.0030	0.0725	0.0193	0.026878	4991	6.45E-06	0.86
			45	0.057	0.75	0.0266	0.0147	0.0377	0.0030	0.0724	0.0312	0.031803	4598	7.92E-06	0.86
			60	0.060	0.78	0.0224	0.0064	0.0344	0.0028	0.0828	0.0175	0.028801	4628	6.96E-06	0.91
			75	0.057	0.78	0.0235	0.0109	0.0377	0.0030	0.0724	0.0192	0.028634	5159	6.93E-06	0.86
			90	0.057	0.78	0.0235	0.0186	0.0293	-0.0060	0.0910	0.0192	0.030414	4901	6.92E-06	0.86
			105	0.057	0.78	0.0256	0.0109	0.0378	0.0030	0.0725	0.0313	0.031095	4765	6.94E-06	0.86
			120	0.057	0.78	0.0246	0.0148	0.0377	0.0030	0.0538	0.0312	0.028103	5075	8.42E-06	0.86
			135	0.057	0.8	0.0227	0.0148	0.0294	0.0031	0.0725	0.0193	0.027843	4993	5.96E-06	0.86
			150	0.063	0.8	0.0219	0.0122	0.0312	0.0024	0.0599	0.0258	0.026280	4168	6.92E-06	0.95
			165	0.057	0.87	0.0277	0.0187	0.0379	0.0032	0.0726	0.0314	0.032743	4580	5.97E-06	0.86
			180	0.057	0.87	0.0267	0.0226	0.0294	0.0300	0.0538	0.0073	0.028612	5032	5.96E-06	0.86
86-07-28		3	15	0.143	0.96	0.0189	0.0183	0.0246	0.0160	0.0233	0.0126	0.018961	552	4.95E-06	2.16
			30	0.137	0.96	0.0181	0.0185	0.0210	0.0174	0.0157	0.0157	0.017651	613	2.12E-05	2.07
			45	0.135	1.1	0.0179	0.0204	0.0201	0.0194	0.0129	0.0119	0.016928	636	2.36E-05	2.04
			75	0.145	1.1	0.0184	0.0199	0.0224	0.0153	0.0196	0.0139	0.018213	664	2.59E-05	2.19
			90	0.101	1	0.0270	0.0219	0.0360	0.0264	0.0290	0.0214	0.026934	696	2.06E-05	1.52
			105	0.095	1	0.0319	0.0302	0.0407	0.0266	0.0328	0.0284	0.031752	706	7.85E-05	1.43
			120	0.097	1	0.0275	0.0260	0.0272	0.0281	0.0313	0.0269	0.027907	602	4.08E-05	1.46
			135	0.095	1.05	0.0273	0.0134	0.0374	0.0358	0.0194	0.0282	0.026822	721	7.88E-05	1.43
			150	0.087	1.05	0.0274	0.0225	0.0196	0.0501	0.0152	0.0233	0.026146	664	4.55E-05	1.31
			165	0.107	1.05	0.0262	0.0281	0.0249	0.0285	0.0258	0.0224	0.025931	643	4.91E-05	1.62
			180	0.099	1.05	0.0253	0.0226	0.0318	0.0273	0.0240	0.0182	0.024780	591	4.01E-05	1.49
			195	0.083	1.06	0.0274	0.0248	0.0216	0.0302	0.0341	0.0313	0.028423	614	3.98E-05	1.25
			210	0.105	1.06	0.0261	0.0315	0.0234	0.0217	0.0268	0.0267	0.026032	555	2.75E-05	1.58
86-08-01		4	15	0.117	1.2	0.0267	0.0272	0.0288	0.0238	0.0304	0.0244	0.026909	652	9.34E-06	1.77
			30	0.119	1.26	0.0223	0.0194	0.0299	0.0212	-0.0048	0.0347	0.020065	717	7.91E-06	1.80
			45	0.115	1.37	0.0272	0.0282	0.0298	0.0269	0.0224	0.0253	0.026525	594	7.88E-06	1.74
			60	0.111	1.4	0.0271	0.0283	0.0365	0.0195	0.0093	0.0335	0.025405	640	8.87E-06	1.68
			75	0.109	1.45	0.0262	0.0186	0.0352	0.0248	0.0197	0.0312	0.025911	755	3.42E-05	1.65
			90	0.105	1.5	0.0287	0.0244	0.0451	0.0240	0.0104	0.0299	0.026756	691	2.91E-05	1.58
			120	0.115	1.35	0.0275	0.0299	0.0317	0.0245	0.0177	0.0281	0.026394	694	1.62E-05	1.74
			150	0.101	1.25	0.0252	0.0220	0.0308	0.0237	0.0053	0.0368	0.023700	761	1.38E-05	1.52
			165	0.115	1.27	0.0246	0.0205	0.0317	0.0245	0.0132	0.0281	0.023602	738	1.57E-05	1.74
			180	0.107	1.29	0.0280	0.0217	0.0345	0.0286	0.0153	0.0360	0.027202	583	8.37E-06	1.62
			195	0.099	1.29	0.0297	0.0307	0.0294	0.0278	0.0179	0.0385	0.028877	634	5.95E-06	1.49
			210	0.101	1.35	0.0291	0.0290	0.0279	0.0234	0.0230	0.0364	0.027936	640	1.17E-05	1.52

86-08-07	800 RPM	Special-1	15	0.145	0.45	0.0260	0.0284	0.0239	0.0210	0.0283	0.0306	0.026427	534	1.06E-05	2.19
	0.03 in. clr.		30	0.137	0.45	0.0281	0.0304	0.0267	0.0220	0.0318	0.0322	0.028613	535	2.21E-05	2.07
			45	0.121	0.5	0.0283	0.0153	0.0271	0.0423	0.0286	0.0310	0.028855	627	8.42E-06	1.83
			60	0.135	0.5	0.0271	0.0190	0.0349	0.0288	0.0260	0.0267	0.027084	562	1.13E-05	2.04
			75	0.121	0.5	0.0262	0.0132	0.0246	0.0391	0.0280	0.0301	0.027010	627	3.86E-05	1.83
			90	0.111	0.62	0.0290	0.0079	0.0296	0.0473	0.0288	0.0364	0.029998	654	4.75E-05	1.68
			105	0.129	0.62	0.0266	0.0205	0.0249	0.0294	0.0318	0.0312	0.027568	635	2.23E-05	1.95
			120	0.129	0.62	0.0267	0.0206	0.0250	0.0296	0.0320	0.0314	0.027730	608	4.04E-05	1.95
86-08-08		Special-2	15	0.159	0.6	0.0240	0.0254	0.0251	0.0230	0.0258	0.0207	0.023994	568	1.67E-05	2.41
			30	0.153	0.6	0.0243	0.0250	0.0233	0.0281	0.0276	0.0172	0.024246	563	4.70E-05	2.32
			45	0.135	0.6	0.0236	0.0323	0.0272	0.0082	0.0324	0.0202	0.024065	594	6.57E-05	2.04
			60	0.135	0.8	0.0255	0.0257	0.0244	0.0365	0.0128	0.0202	0.023920	653	5.13E-05	2.04
			75	0.101	0.8	0.0344	0.0388	0.0491	0.0262	0.0408	0.0137	0.033720	611	4.35E-05	1.52
			90	0.125	0.73	0.0263	0.0222	0.0182	0.0393	0.0266	0.0263	0.026521	554	1.52E-05	1.89
			105	0.129	0.75	0.0270	0.0359	0.0302	0.0092	0.0359	0.0271	0.027647	594	1.20E-05	1.95
86-08-10	1000 RPM	5	15	0.191	0.65	0.0265	0.0216	0.0262	0.0363	0.0277	0.0206	0.026477	554	1.03E-05	2.90
	0.03 in. clr.		30	0.151	0.65	0.0290	0.0261	0.0480	0.0332	-0.0214	0.0332	0.023826	494	1.67E-05	2.29
			45	0.153	0.7	0.0282	0.0466	0.0121	0.0261	0.0305	0.0240	0.027859	495	1.57E-05	2.32
			60	0.153	0.7	0.0284	0.0202	0.0412	0.0263	0.0306	0.0242	0.028489	512	2.62E-05	2.32
			75	0.141	0.8	0.0280	0.0419	0.0208	0.0203	0.0266	0.0280	0.027538	532	5.33E-05	2.13
			90	0.157	0.8	0.0284	0.0009	0.0603	0.0303	0.0288	0.0226	0.028576	551	6.13E-05	2.38
			105	0.143	0.8	0.0273	0.0288	0.0334	0.0157	0.0201	0.0367	0.026954	555	6.62E-05	2.16
			120	0.139	0.7	0.0280	0.0331	0.0215	0.0092	0.0522	0.0389	0.030968	511	4.24E-05	2.10
			135	0.165	0.7	0.0276	0.0353	0.0202	0.0380	0.0217	0.0163	0.026298	576	6.05E-05	2.50
			150	0.181	0.73	0.0287	0.0254	0.0330	0.0357	0.0216	0.0228	0.027708	527	3.26E-05	2.74
			165	0.157	0.73	0.0281	0.0291	0.0389	0.0132	0.0411	0.0229	0.029036	539	2.80E-05	2.38
			180	0.147	0.77	0.0299	0.0480	0.0318	0.0216	0.0247	0.0135	0.027909	571	2.45E-05	2.23
			195	0.145	0.85	0.0258	0.0341	0.0160	0.0331	0.0197	0.0212	0.024823	543	3.28E-05	2.19
86-08-10	1000 RPM	6	15	0.127	0.8	0.0234	0.0184	0.0261	0.0256	0.0258	0.0231	0.023767	2697	1.13E-05	1.92
	0.03 in. clr.		30	0.127	0.8	0.0251	0.0151	0.0424	0.0234	0.0182	0.0228	0.024393	2270	4.57E-05	1.92
			45	0.127	0.8	0.0257	0.0214	0.0293	0.0237	0.0331	0.0254	0.026570	2121	1.67E-05	1.92
			60	0.125	0.81	0.0255	0.0219	0.0266	0.0278	0.0264	0.0259	0.025712	2202	3.50E-05	1.89
			75	0.123	0.81	0.0242	0.0177	0.0274	0.0268	0.0272	0.0242	0.024654	2206	5.04E-05	1.86
			90	0.129	0.85	0.0248	0.0236	0.0250	0.0279	0.0284	0.0198	0.024933	2109	3.70E-05	1.95
			105	0.127	0.85	0.0250	0.0184	0.0260	0.0326	0.0257	0.0230	0.025121	2235	4.51E-05	1.92
			120	0.127	0.85	0.0248	0.0167	0.0308	0.0270	0.0293	0.0228	0.025345	2178	3.46E-05	1.92
			135	0.121	0.92	0.0251	0.0150	0.0303	0.0298	0.0282	0.0252	0.025715	2310	4.39E-05	1.83
			150	0.115	0.92	0.0267	0.0206	0.0381	0.0291	0.0224	0.0194	0.025918	2213	7.39E-06	1.74
			165	0.129	0.8	0.0269	0.0237	0.0300	0.0281	0.0285	0.0246	0.026981	2153	4.70E-05	1.95
			180	0.121	0.86	0.0293	0.0305	0.0287	0.0281	0.0448	0.0201	0.030425	2112	1.96E-05	1.83
86-08-11		7	15	0.107	0.93	0.0240	0.0173	0.0273	0.0285	0.0311	0.0190	0.024649	3600	3.49E-05	1.62
			30	0.105	0.92	0.0242	0.0133	0.0257	0.0320	0.0322	0.0231	0.025258	3621	4.00E-05	1.58
			45	0.105	0.97	0.0254	0.0201	0.0234	0.0321	0.0323	0.0232	0.026224	3522	3.73E-05	1.58
			60	0.111	0.97	0.0222	0.0180	0.0231	0.0264	0.0337	0.0145	0.023135	3542	2.30E-05	1.68
			75	0.105	0.9	0.0273	0.0203	0.0309	0.0297	0.0379	0.0233	0.028413	3375	1.58E-05	1.58
			90	0.101	0.92	0.0296	0.0219	0.0307	0.0350	0.0410	0.0252	0.030764	3369	1.48E-05	1.52
			105	0.105	0.92	0.0266	0.0224	0.0283	0.0321	0.0322	0.0197	0.026931	3496	1.76E-05	1.58
			120	0.101	0.91	0.0293	0.0217	0.0305	0.0346	0.0348	0.0288	0.030070	3404	3.47E-05	1.52
			135	0.101	0.9	0.0273	0.0168	0.0331	0.0345	0.0348	0.0212	0.028054	3510	4.04E-05	1.52
			150	0.105	0.88	0.0272	0.0179	0.0307	0.0347	0.0322	0.0232	0.027743	3323	2.55E-05	1.58
			165	0.101	0.88	0.0269	0.0218	0.0280	0.0320	0.0349	0.0213	0.027598	3459	2.06E-05	1.52
			180	0.097	0.87	0.0258	0.0104	0.0305	0.0380	0.0380	0.0191	0.027184	3683	1.67E-05	1.46
86-08-12		8	10	0.236	0.67	0.0313	0.0289	0.0398	0.0152	0.0340	0.1326	0.050117	276	4.17E-06	3.57
			20	0.227	0.67	0.0316	0.0277	0.0409	0.0198	0.0348	0.1088	0.046411	278	4.48E-06	3.44

	30	0.179	0.9	0.0335	0.0249	0.0482	0.0208	0.0390	0.1561	0.057789	297	4.26E-06	2.71
	40	0.153	0.9	0.0462	0.0468	0.0657	0.0108	0.0417	0.1883	0.070652	275	1.97E-05	2.32
	50	0.119	0.72	0.0468	0.0212	0.0414	0.0181	0.0421		0.030685	2203	4.76E-06	1.80
	60	0.117	0.72	0.0466	0.0219	0.0354	0.0187	0.0436		0.029891	2215	4.86E-06	1.77
	70	0.119	0.81	0.0483	0.0247	0.0341	0.0222	0.0421		0.030758	2131	4.25E-06	1.80
	80	0.121	0.81	0.0477	0.0239	0.0400	0.0175	0.0491		0.032648	1961	5.16E-06	1.83
	90	0.119	0.91	0.0491	0.0246	0.0412	0.0180	0.0420		0.031481	2029	6.32E-06	1.80
	100	0.117	0.91	0.0498	0.0236	0.0352	0.0229	0.0524		0.033530	1953	1.05E-05	1.77
	110	0.119	1.02	0.0498	0.0263	0.0375	0.0137	0.0505		0.032012	1992	8.07E-06	1.80
	120	0.121	1.3	0.0506	0.0273	0.0329	0.0134	0.0490		0.030637	2018	7.61E-06	1.83
86-08-07 800 RPM Water Tes	15	0.185	0.42	0.0254	0.0250	0.0293	0.0178	0.0327	0.0259	0.026132	505	9.45E-07	2.80
0.03 in. clr.	30	0.185	0.42	0.0254	0.0250	0.0293	0.0208	0.0265	0.0259	0.025481	514	9.52E-07	2.80
	45	0.191	0.42	0.0247	0.0262	0.0237	0.0251	0.0248	0.0232	0.024602	502	1.07E-06	2.90
	60	0.189	0.42	0.0247	0.0268	0.0250	0.0240	0.0254	0.0215	0.024517	515	1.05E-06	2.87
86-08-10 1000 RPM	15	0.238	0.65	0.0271	0.0246	0.0085	0.0499	0.0291	0.0258	0.027594	465	1.03E-06	3.60
0.03 in. clr.	30	0.238	0.65	0.0271	0.0255	0.0075	0.0499	0.0291	0.0258	0.027579	462	1.03E-06	3.60
	45	0.238	0.65	0.0271	0.0255	0.0075	0.0499	0.0291	0.0258	0.027579	462	1.02E-06	3.60
	60	0.238	0.65	0.0270	0.0260	0.0075	0.0489	0.0291	0.0258	0.027461	464	1.02E-06	3.60
	75	0.238	0.65	0.0271	0.0264	0.0066	0.0525	0.0237	0.0258	0.026998	464	1.03E-06	3.60
	90	0.238	0.65	0.0270	0.0340	0.0002	0.0504	0.0258	0.0237	0.026856	466	1.02E-06	3.60
86-08-13 1000 RPM	10	0.225	0.9	0.0338	0.0303	0.0438	0.0180	0.0356	0.1459	0.054715	438	1.05E-06	3.41
0.03 in. clr.	20	0.225	0.9	0.0340	0.0298	0.0448	0.0180	0.0356	0.1575	0.057132	433	1.04E-06	3.41
	30	0.127	0.72	0.0467	0.0266	0.0366	0.0235	0.0448		0.032874	2189	1.01E-06	1.92
	40	0.125	0.72	0.0466	0.0275	0.0312	0.0243	0.0462		0.032300	2190	1.01E-06	1.89
	50	0.125	0.72	0.0459	0.0259	0.0312	0.0243	0.0462		0.031894	2218	1.01E-06	1.89
86-08-13 1000 RPM	15	0.217	0.5	0.0288	0.0192	0.0287	0.0155	0.0308		0.023574	857	1.04E-06	3.29
0.03 in. clr.	30	0.246	0.6	0.0316	0.0235	0.0301	0.0191	0.0323		0.026241	480	1.03E-06	3.72
	45	0.246	0.55	0.0315	0.0239	0.0301	0.0181	0.0323		0.026099	470	1.03E-06	3.72
	60	0.244	0.55	0.0318	0.0243	0.0298	0.0194	0.0328		0.026567	463	1.03E-06	3.69
	75	0.227	0.55	0.0325	0.0234	0.0331	0.0188	0.0329		0.027067	599	1.03E-06	3.44
	90	0.227	0.56	0.0323	0.0229	0.0322	0.0188	0.0353		0.027290	598	1.03E-06	3.44
	105	0.209	0.55	0.0327	0.0236	0.0298	0.0174	0.0360		0.026721	777	1.02E-06	3.17
	120	0.211	0.53	0.0324	0.0235	0.0292	0.0184	0.0340		0.026274	774	1.02E-06	3.20
	135	0.258	0.53	0.0351	0.0270	0.0347	0.0214	0.0377		0.030186	271	1.02E-06	3.90
	150	0.258	0.57	0.0352	0.0274	0.0343	0.0209	0.0386		0.030304	277	1.02E-06	3.90
	165	0.252	0.55	0.0321	0.0251	0.0303	0.0186	0.0327		0.026702	405	1.02E-06	3.81
	180	0.252	0.55	0.0321	0.0251	0.0303	0.0186	0.0327		0.026702	405	1.02E-06	3.81

Figure 1
Pipeline Profile
No Elbow

Gauge		Elevation	Pipe	Length	Station	Area
Deck		99.25				
	1	99.82	0.203	0	0	0.032365
	2	99.29	0.23	14.9	14.9	0.041547
	3	99.28	0.23	3.15	18.05	0.041547
	4	99.27	0.29	18.5	36.55	0.066051
	5	99.38	0.29	100	136.55	0.066051
	6	99.33	0.29	92	228.55	0.066051
	7	99.7	0.29	86.6	315.15	0.066051
	8	99.51	0.29	41.4	356.55	0.066051
	9	99.55	0.29	64.4	420.95	0.066051
outlet		100.32	0.29	15.8	436.75	0.066051
					304.4	

APPENDIX E

NOTES ON DESIGN OF A PEAT SLURRY PUMPING/PIPELINE SYSTEM

NOTES ON PEAT SLURRY PIPELINE DESIGN

Solids Content

Select a solids content, c, as a first estimate of an economic system design.

Pipeline Layout

For given solids content and production rate, find the total slurry flowrate:

$$Q = f\ (c)$$

This should be close to the pump best efficiency point.

Select a preliminary pipe size as a nearest even manufacturer's size to give a velocity of 1.5 - 2.5 m/s.

$$D = Q/2\ \text{m/s}$$

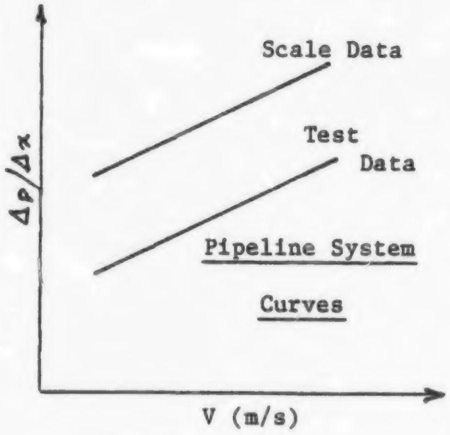
Determine the length of pipeline from the start and end of the mining pit to the discharge pond.

$$L = \text{pipe length.}$$

Hydraulic Design

- Plot the data for velocity versus head loss.
- Scale head loss and velocity to estimate pipe diameter.

$$\tau_w = \frac{\Delta pD}{4L}, \text{ and}$$



$$U^* = \sqrt{\tau_w/p}$$

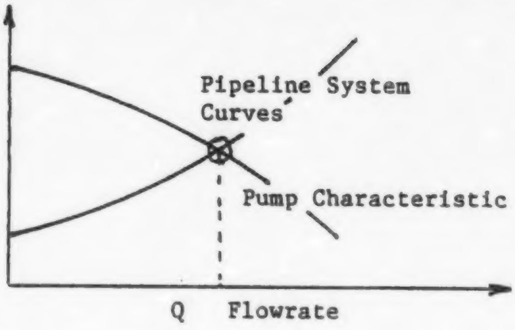
where:

p = fluid density, kg/m^3,
τ_w = wall shear stress,
Δp = head loss,
L = pipe length,
D = pipe diameter and
U* = shear velocity.

$$V_2 = V_1 + 2.5\,U^* \ln(D_2/D_1)$$

$$(\Delta p/\Delta x)_2 = (\Delta p/\Delta x)_1\,(D_1/D_2)$$

For the selected solids content, find the pump characteristic curve and plot the scaled head loss versus flowrate data on the same graph.


Pipeline System Curves
Pump Characteristic
Q
Flowrate

The intersection of the pipeline system and pump characteristc curves will give the actual system flowrate.

Optimization of Diameter

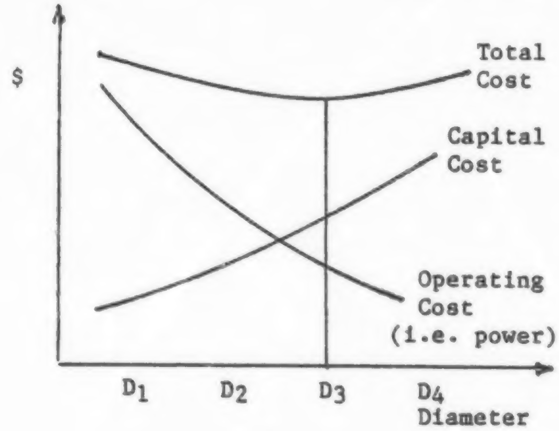
For the actual Q and solids content find:

- pump power demand,
- pump operating cost for the life of the mining pit,
- capital cost of the pipeline, and
- revenue earned by peat harvested.

At this point the pipe diameter should be changed to yield a set of points which relate the pump operating cost and the pipe capital cost.

The total cost is the sum of the capital cost of the pipe and the present value of the operating cost.

The minimum value of the total cost gives the optimum pipe diameter.

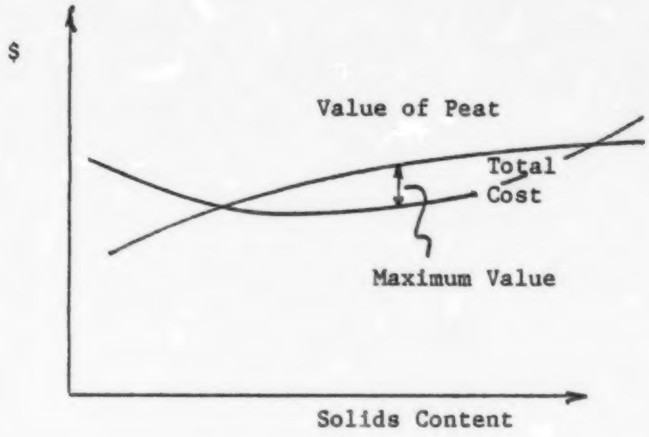

$
Total Cost
Capital Cost
Operating Cost (i.e. power)
D1
D2
D3
D4
Diameter

Length of Mining Pit

Because the length of the pipeline will change during the life of the mining pit, the analysis of operating costs should include the reduction in flowrate as the length of pipeline increases and the change in the power demand, i.e., one pipeline diameter will have several different lengths through the life of the mining pit.

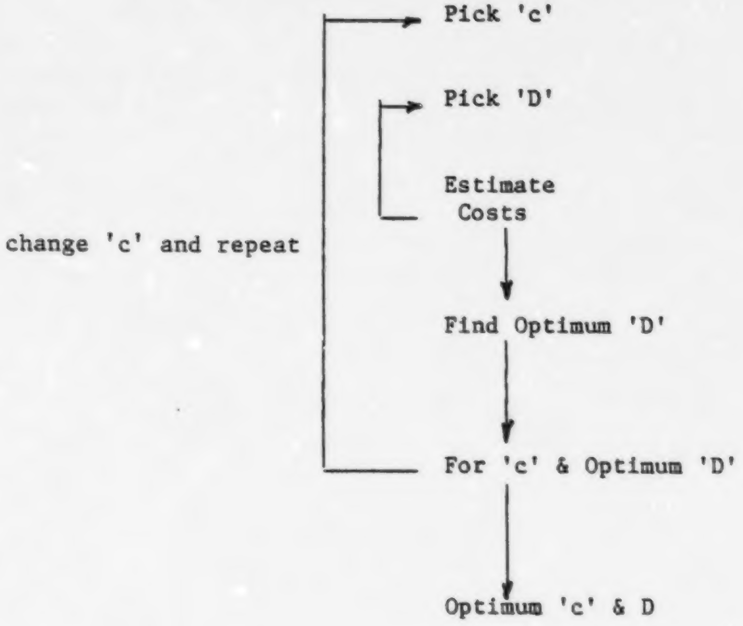
Optimization of Solids Content

The solids content should be changed and the analysis repeated to find the optimimum solids content and pipe diameter. In this case, the total cost of each pipe system (different diameters) is plotted with the value of the peat harvested to give the highest present value.



Summary on Design

A single expression cannot give the most economic pipe diameter and pipe length. An economic analysis must be carried out to determine the minimum cost pipeline which gives the highest peat yield. This process is carried out for the design of all major pipelines.


Pick 'c'
Pick 'D'
Estimate Costs
change 'c' and repeat
Find Optimum 'D'
For 'c' & Optimum 'D'
Optimum 'c' & D

Capital and Operating Costs for a Typical System

The following are order-of-magnitude capital and operating costs for a typical modified 'hydropeat' system producing peat slurry as a product and are based on the test system characteristics (e.g. 300 mm diameter pipeline) and relatively short pipeline lengths, and have not been optimized for long term production.

Capital costs are estimated to be:

Production Rate	Capital Costs ($)
180,000 tonnes/year output (50% moisture content equivalent tonnes)	1.3 million
270,000 tonnes/year output (50% moisture content equivalent tonnes)	1.8 million

The above total capital costs include equipment, 5000 m of pipeline for the lower production rate and 7500 m of pipeline for the higher rate, fittings, electrical switchgear and transformers, but exclude booster pumps (if required), installation, working capital, engineering, power lines, etc.

Annual operating costs are estimated to be $1.1 million and $1.6 million for the smaller and larger production rates, respectively. Operating costs include fuel, power, operating personnel, maintenance and supplies, surface preparation for new mining areas and drying field berm and ditch construction.

APPENDIX F

SETTLING AND DEWATERABILITY CURVES

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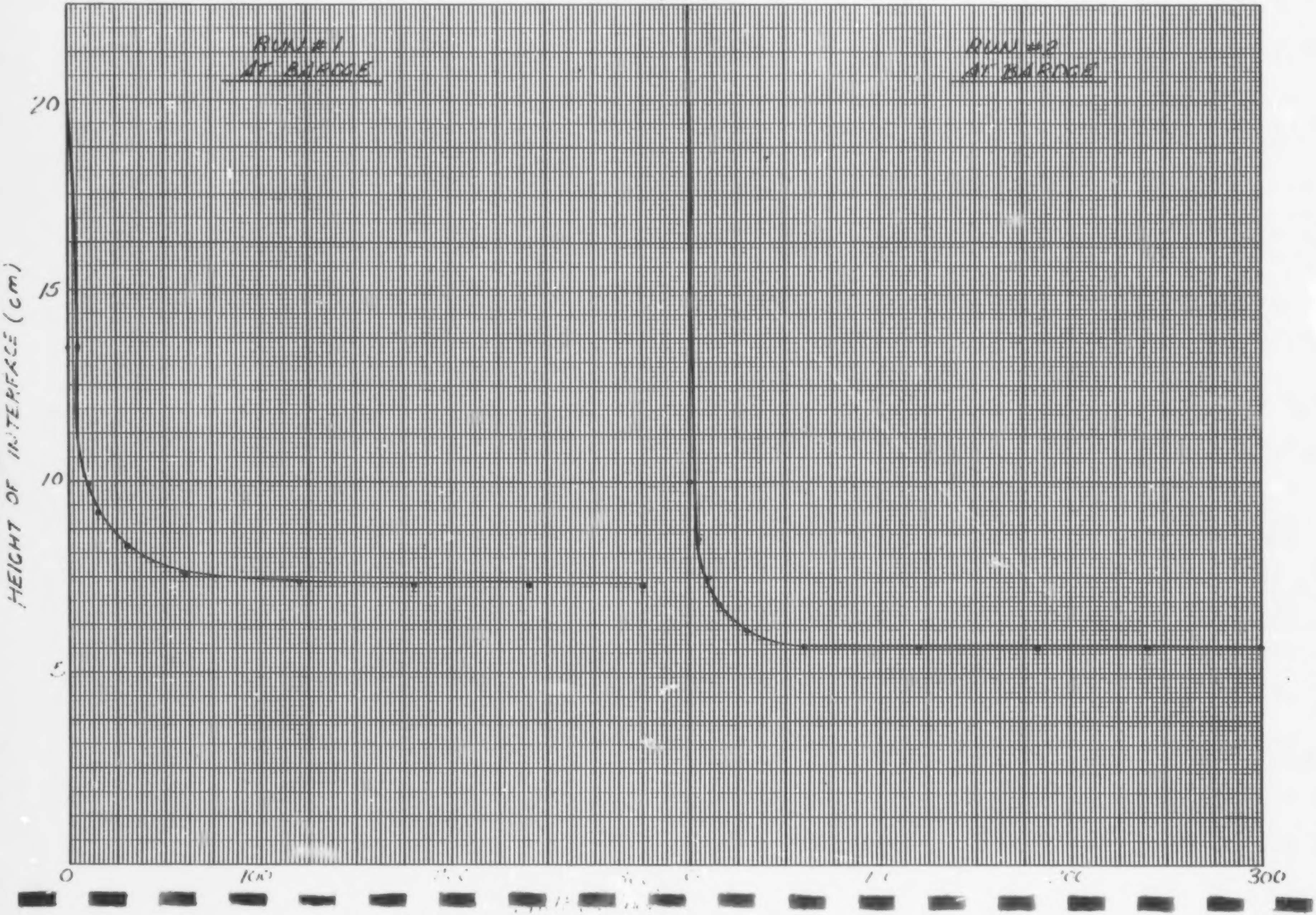
HEIGHT OF INTERFACE
VS. TIME



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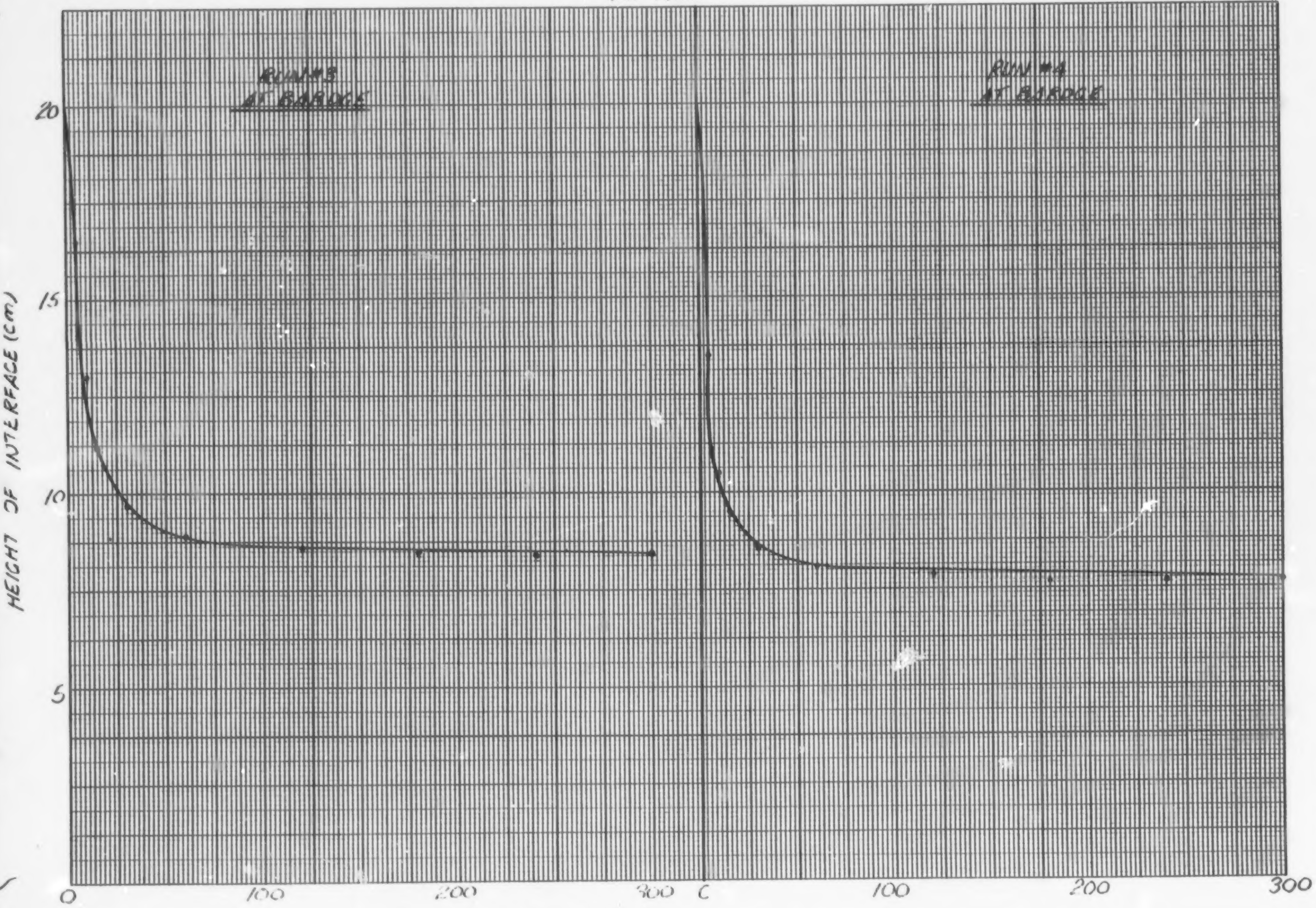

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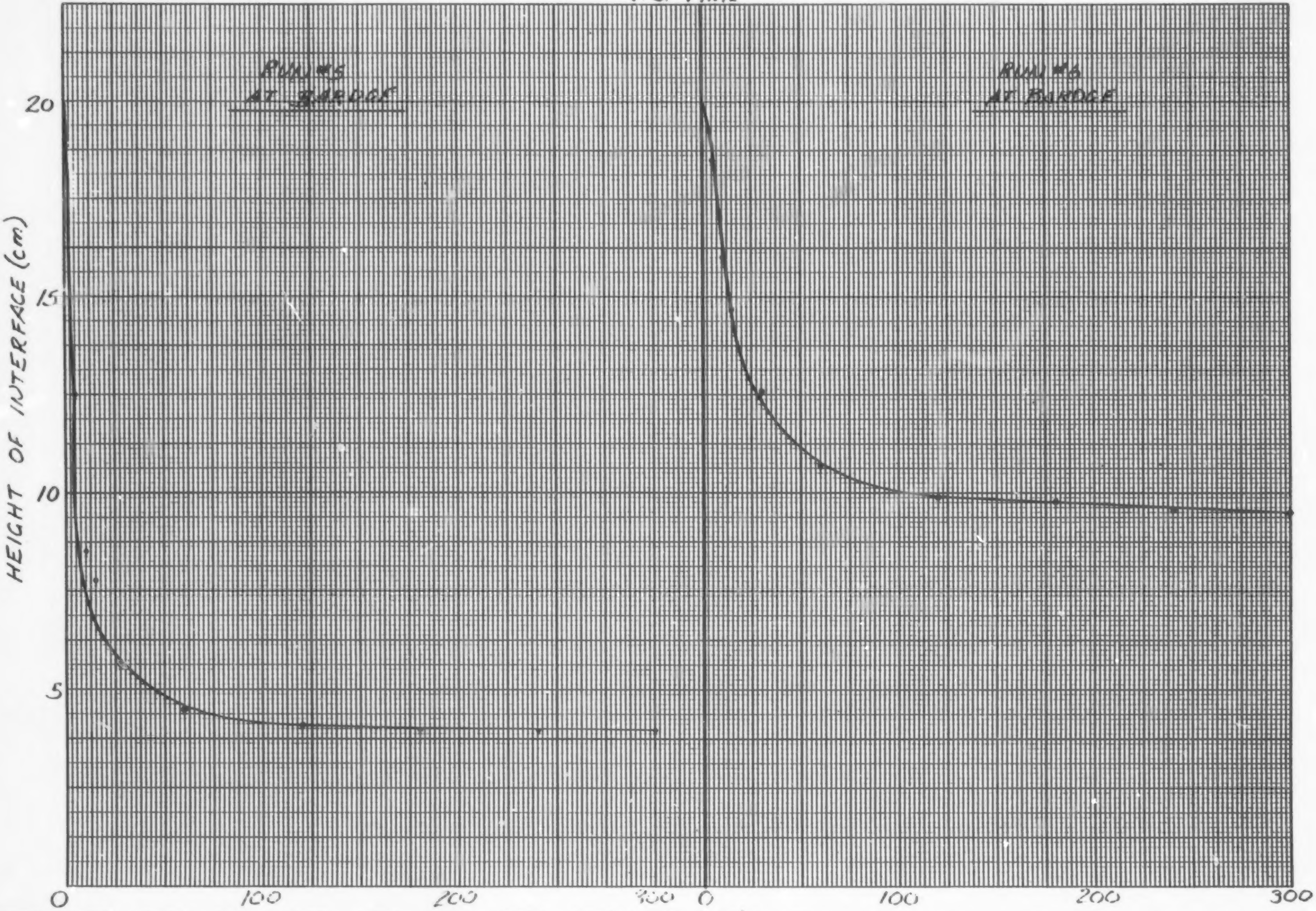

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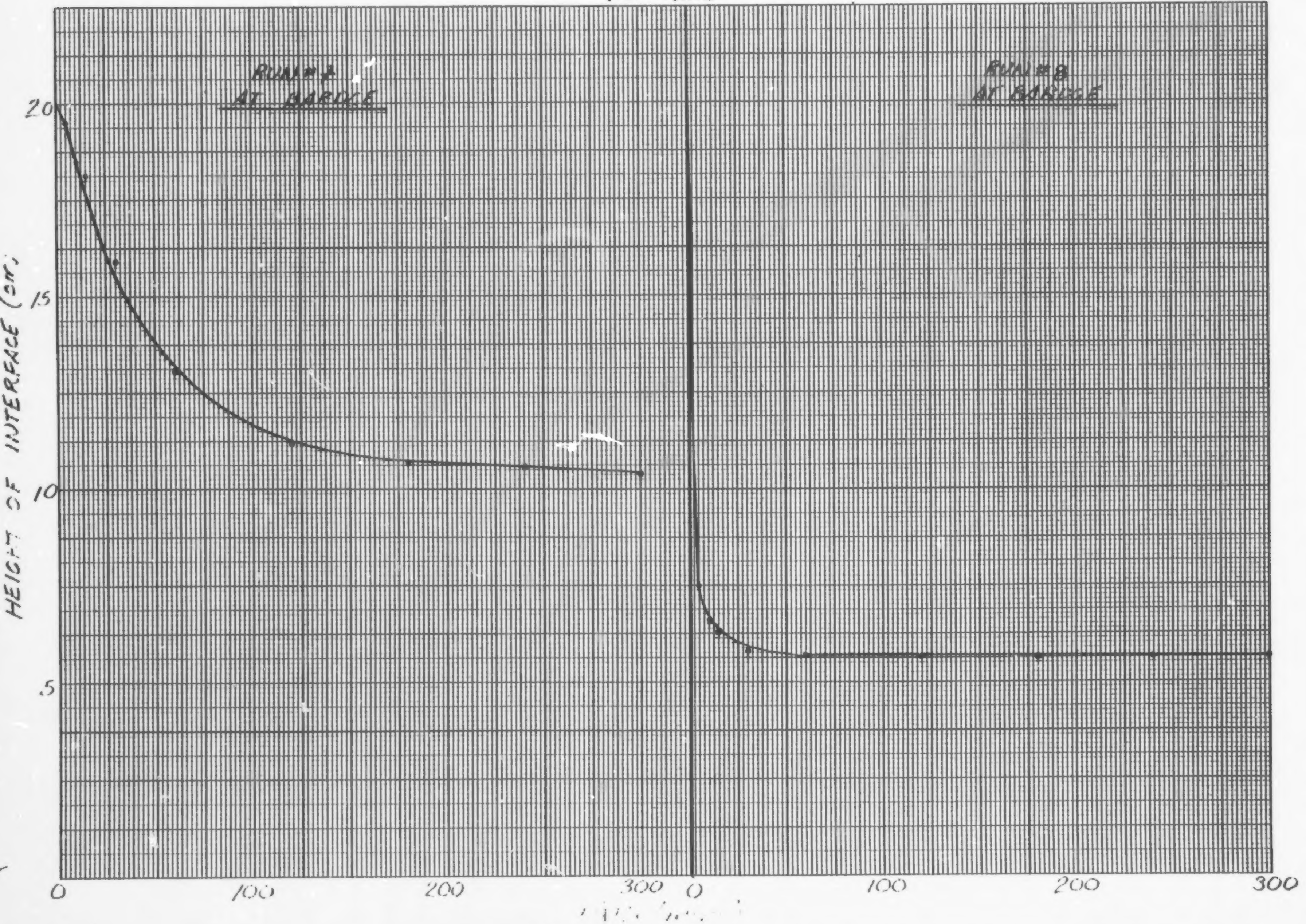

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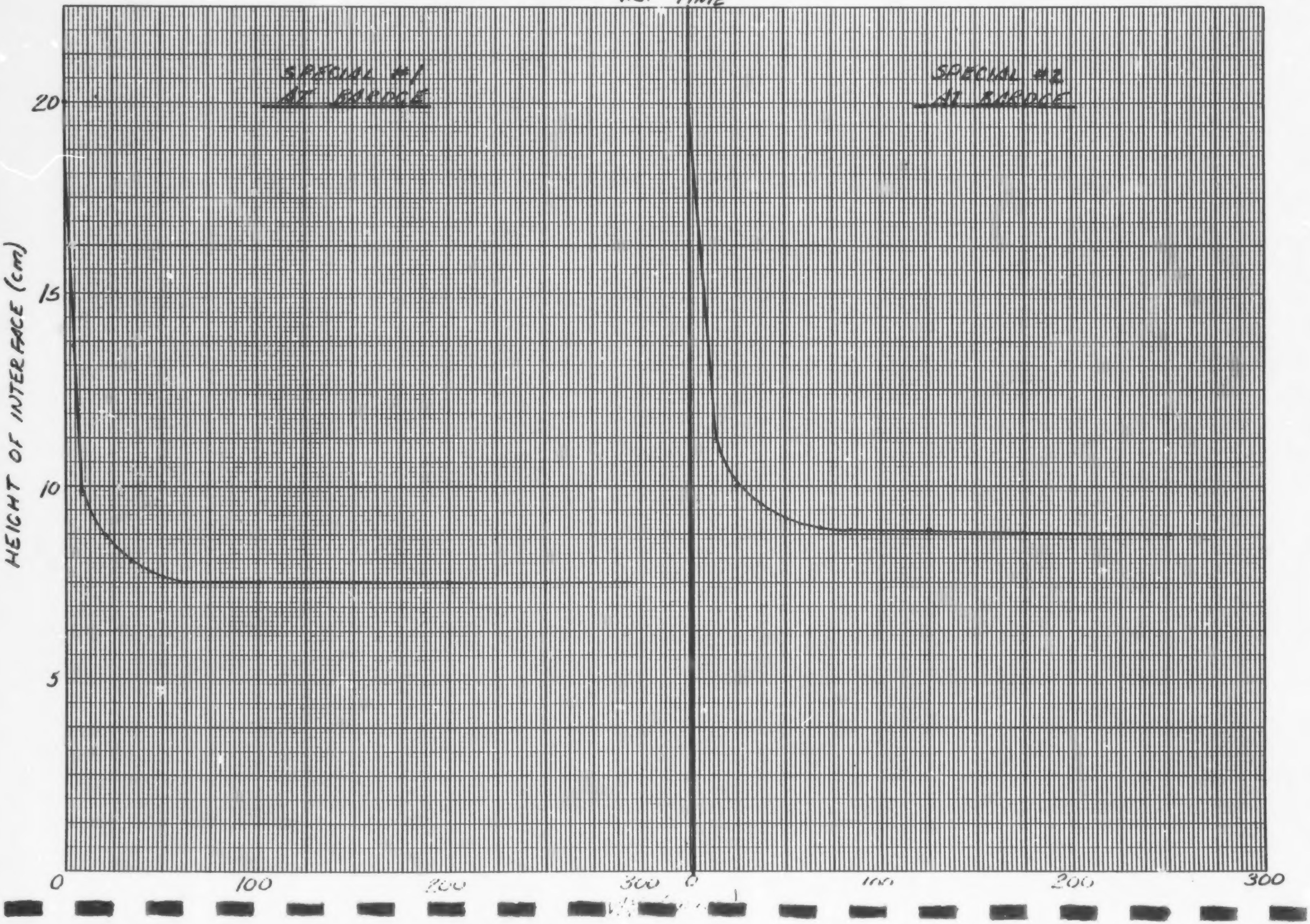
HEIGHT OF INTERFACE
V.S. TIME



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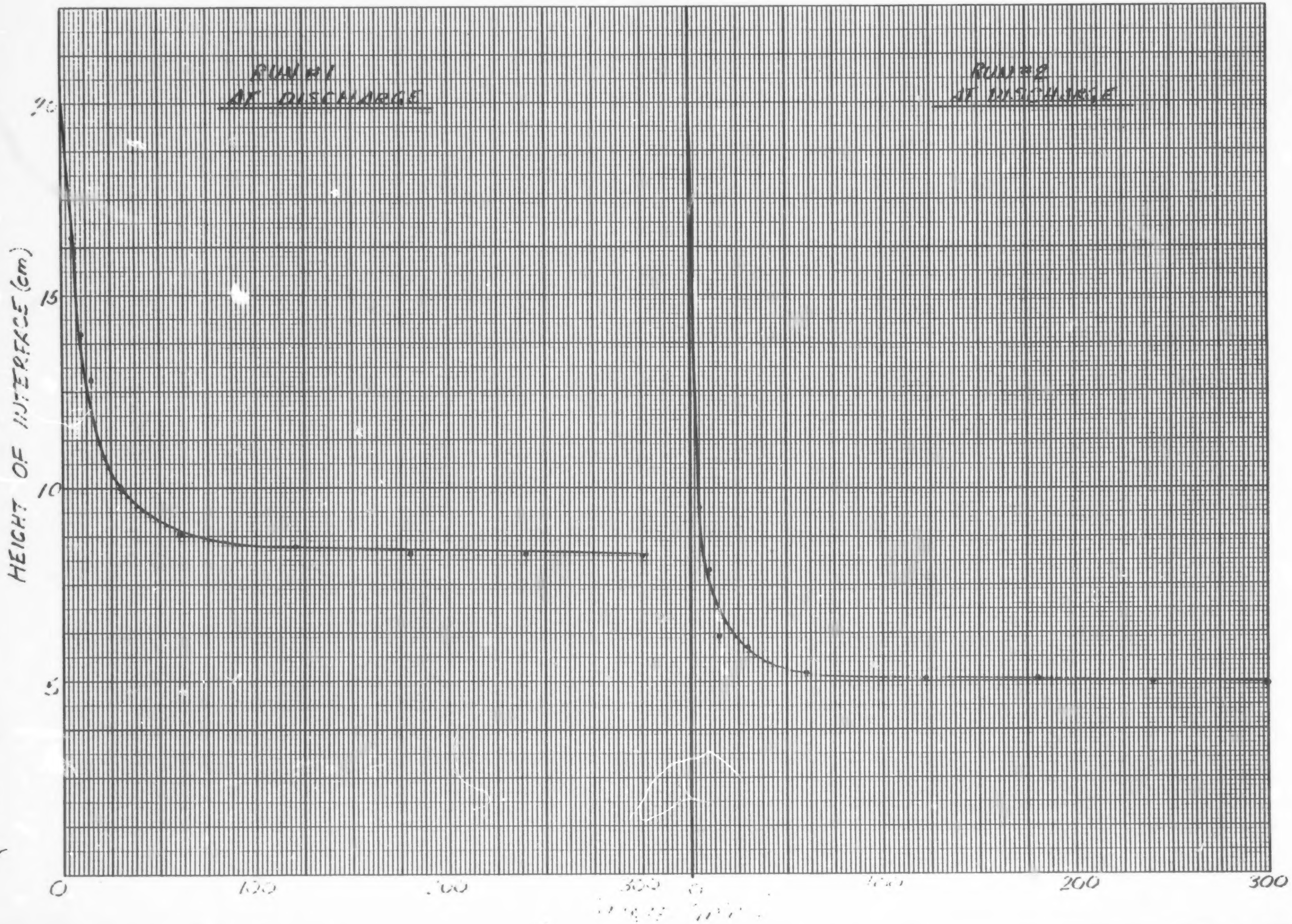

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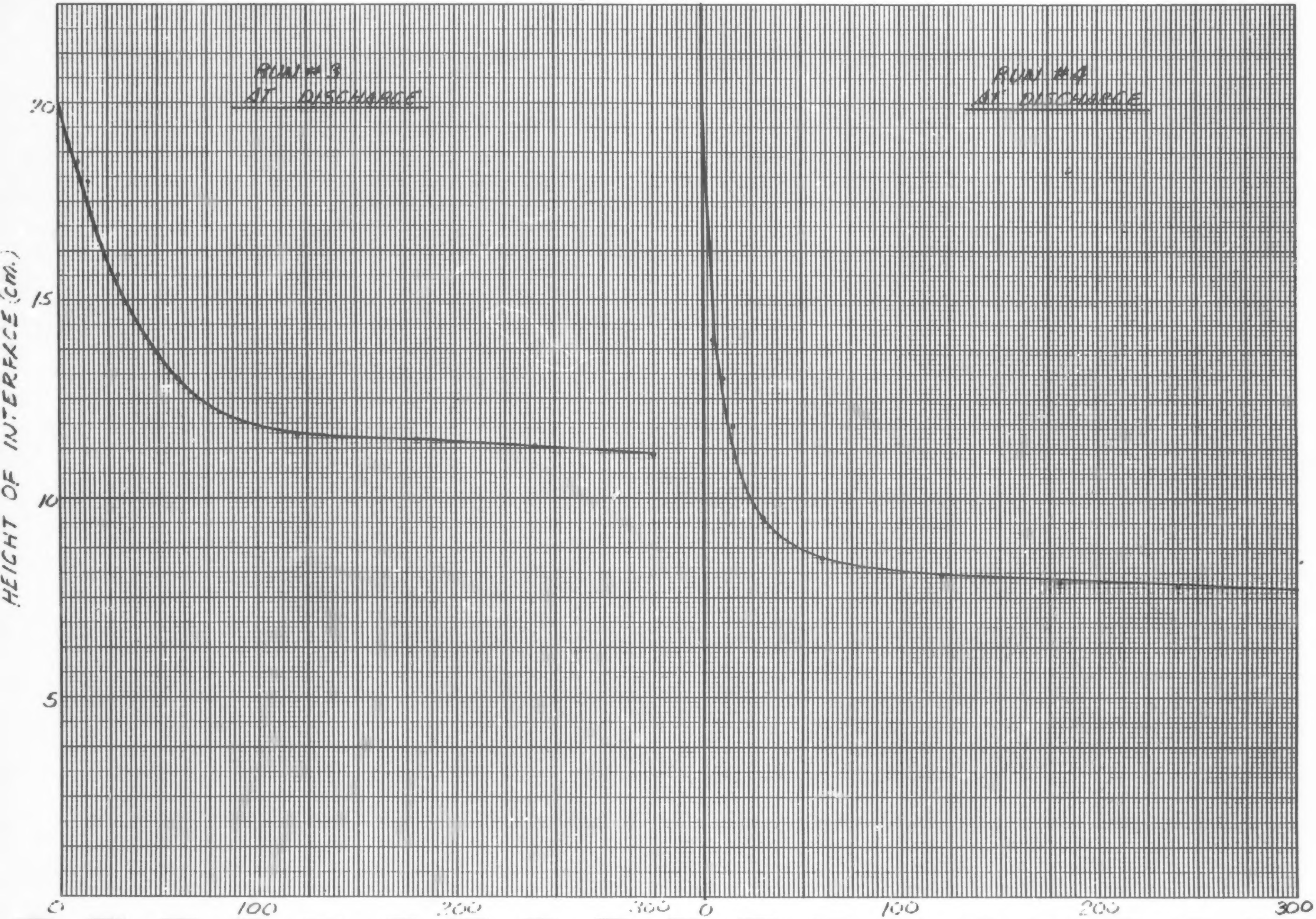

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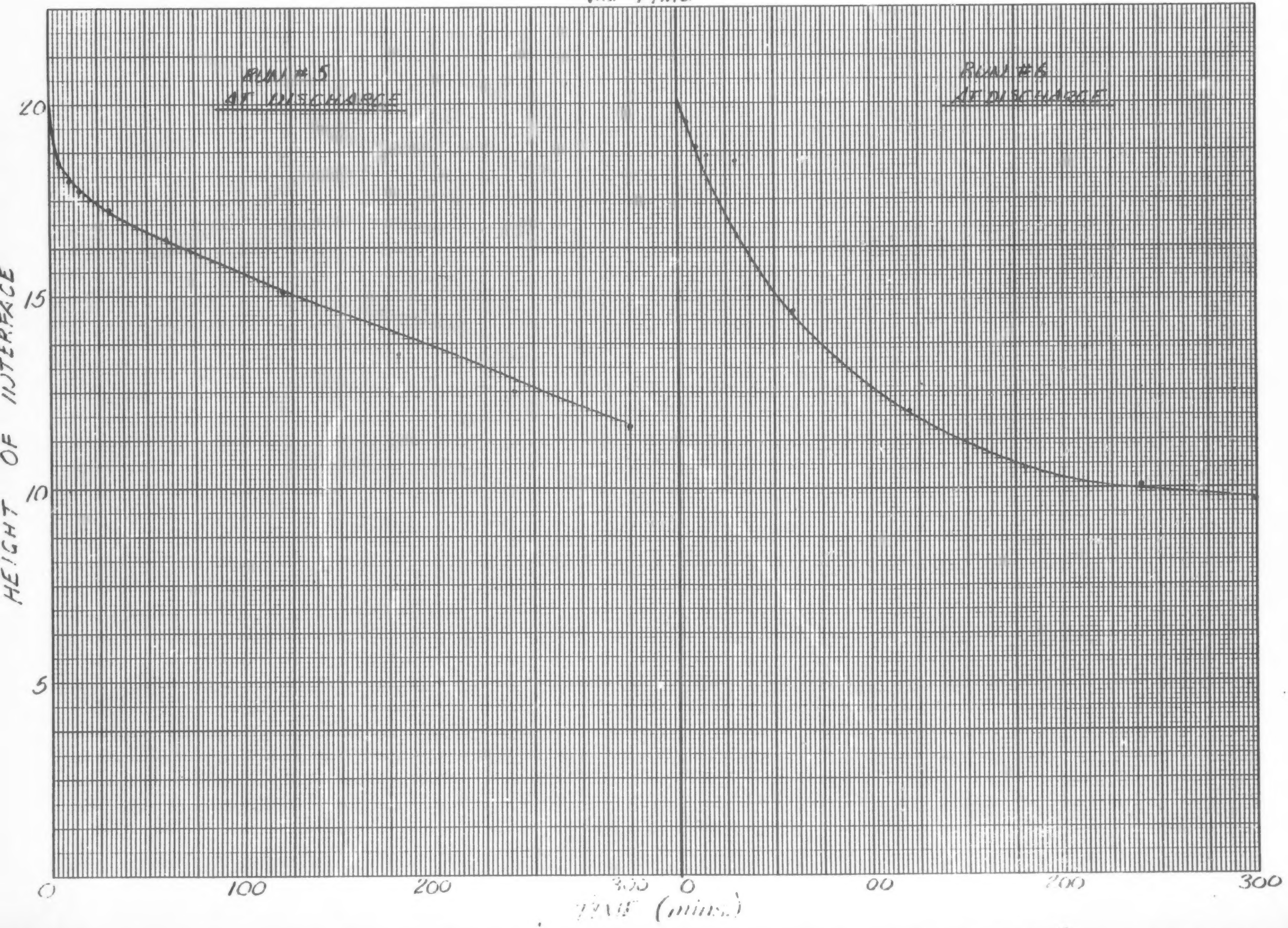

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HEIGHT OF INTERFACE
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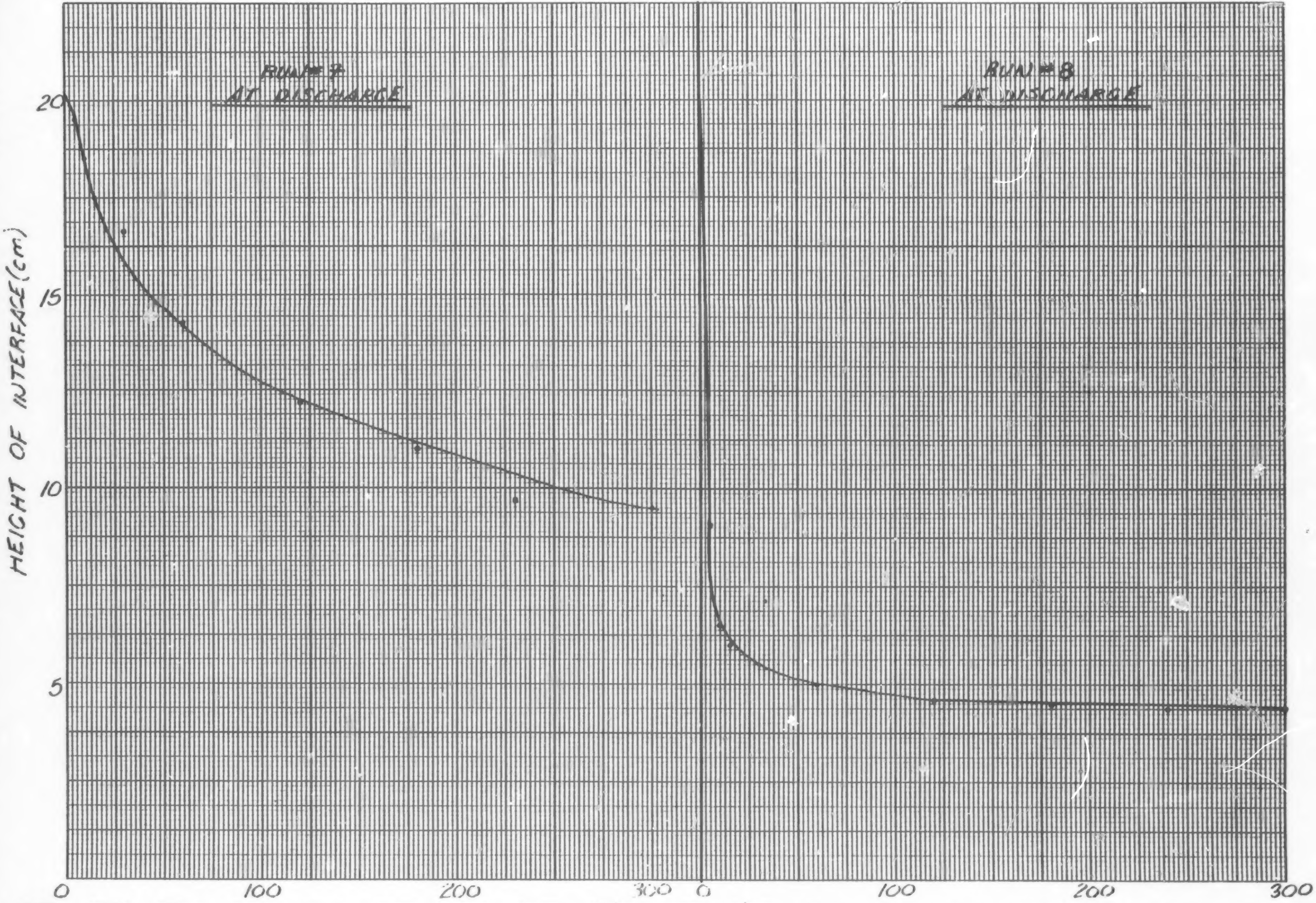

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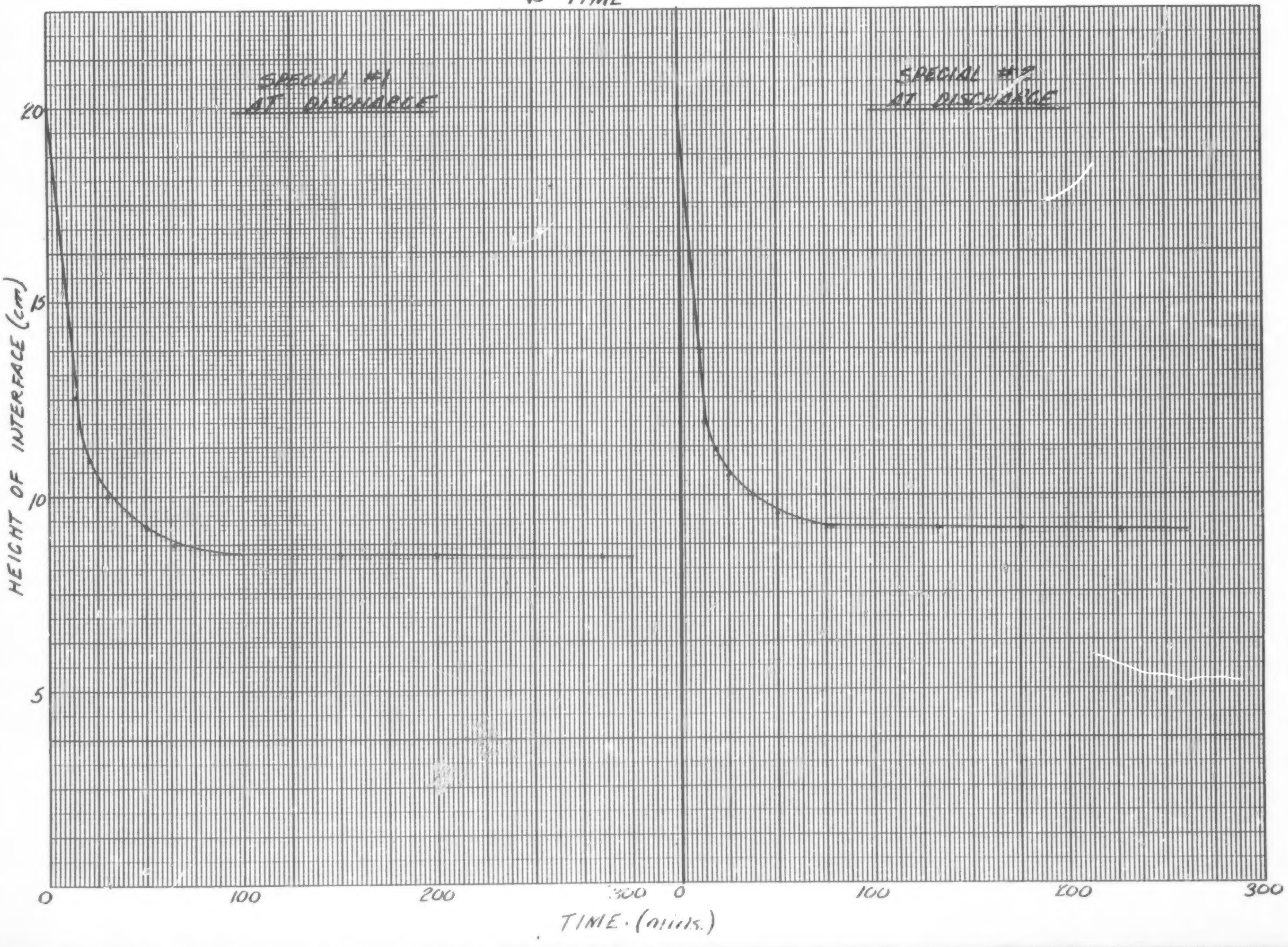
HEIGHT OF INTERFACE
VS TIME



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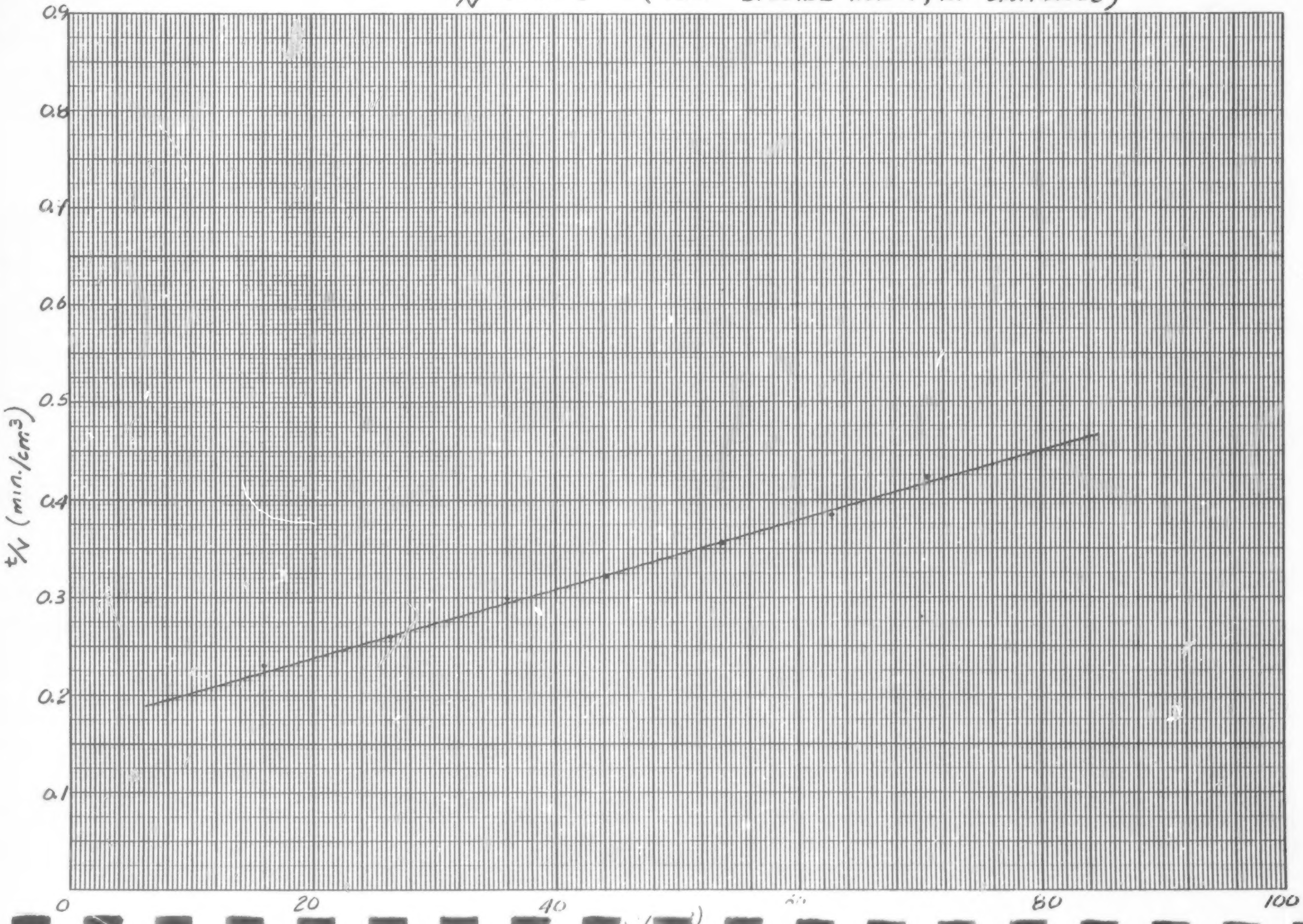

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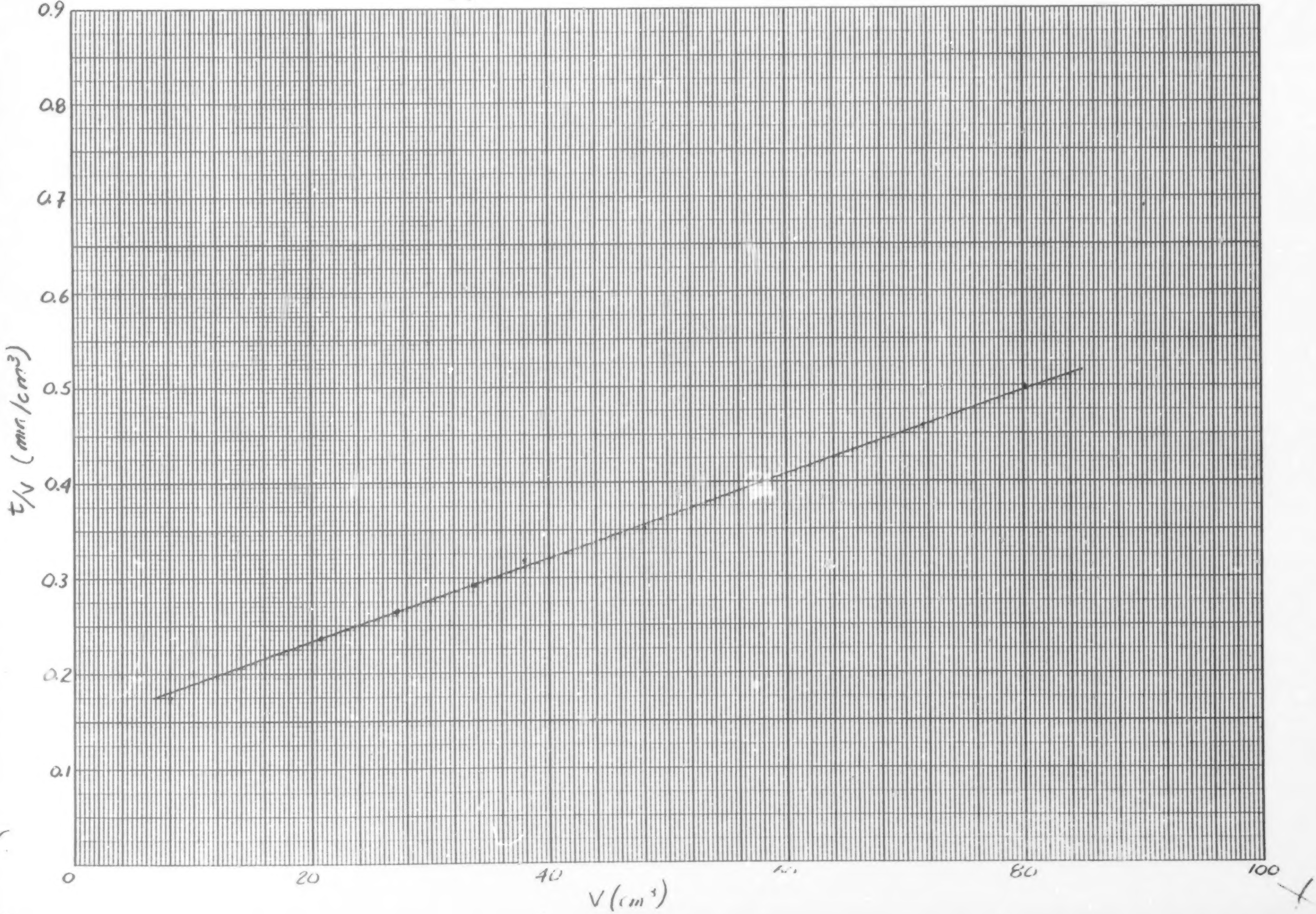

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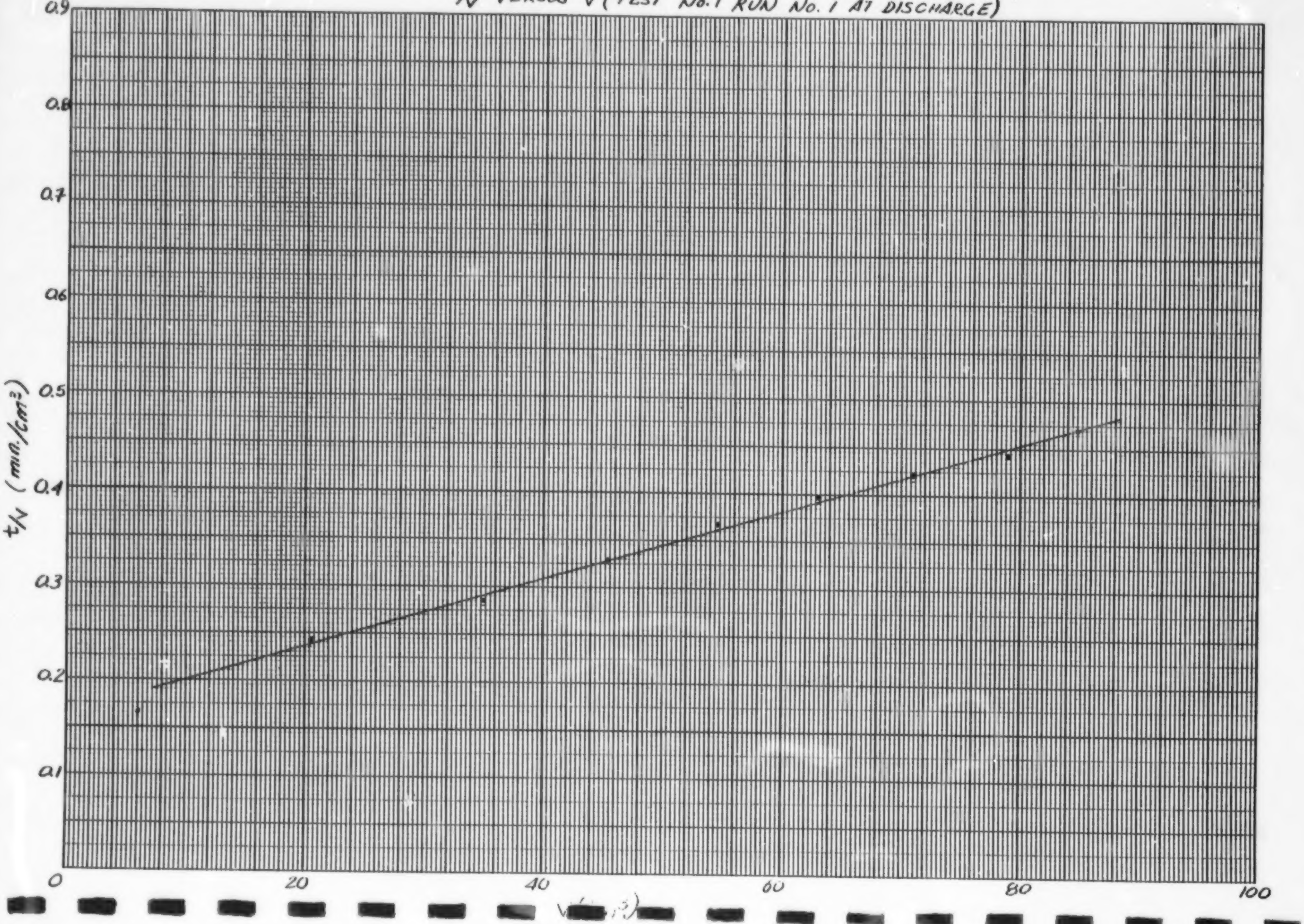

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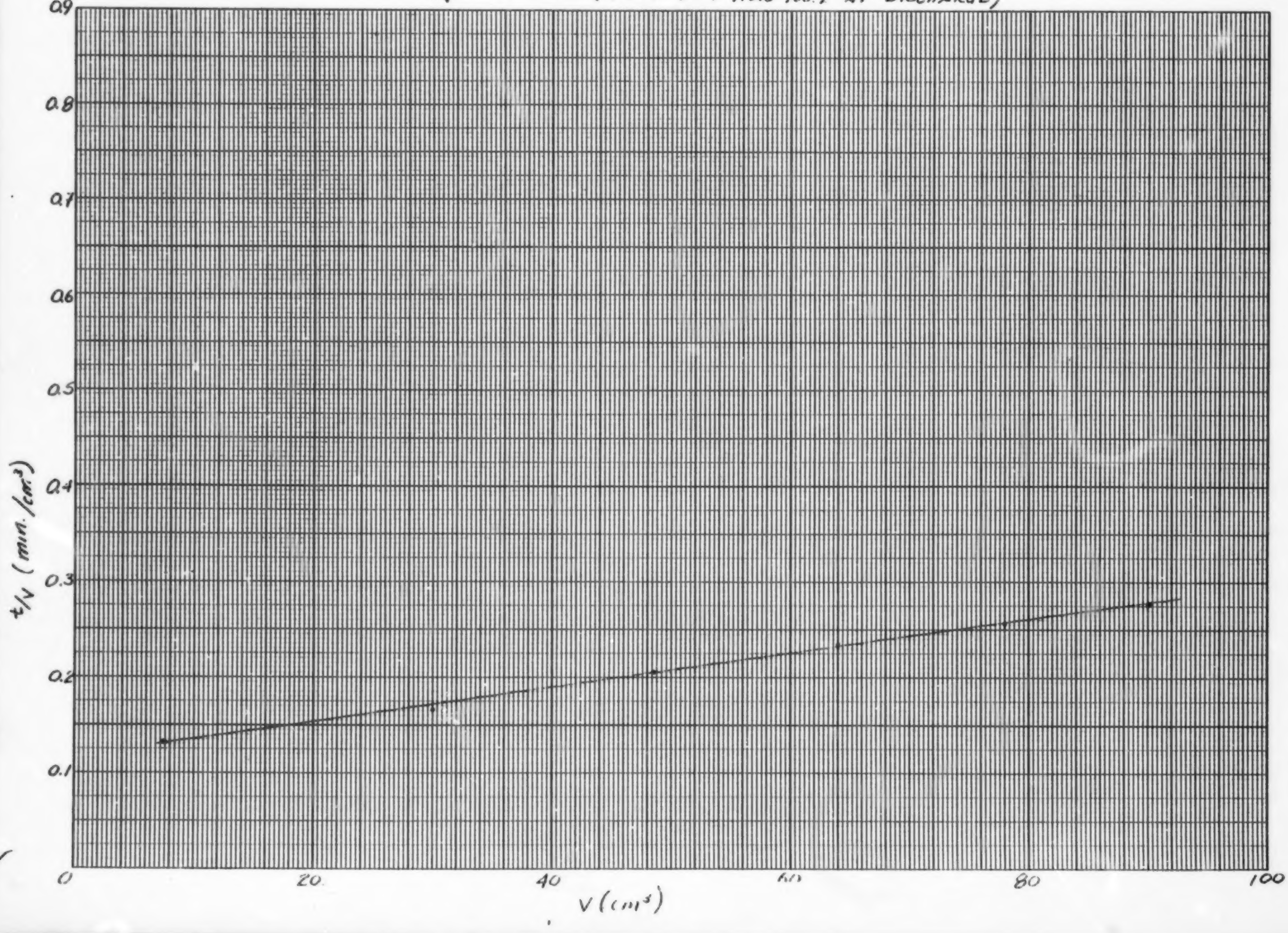

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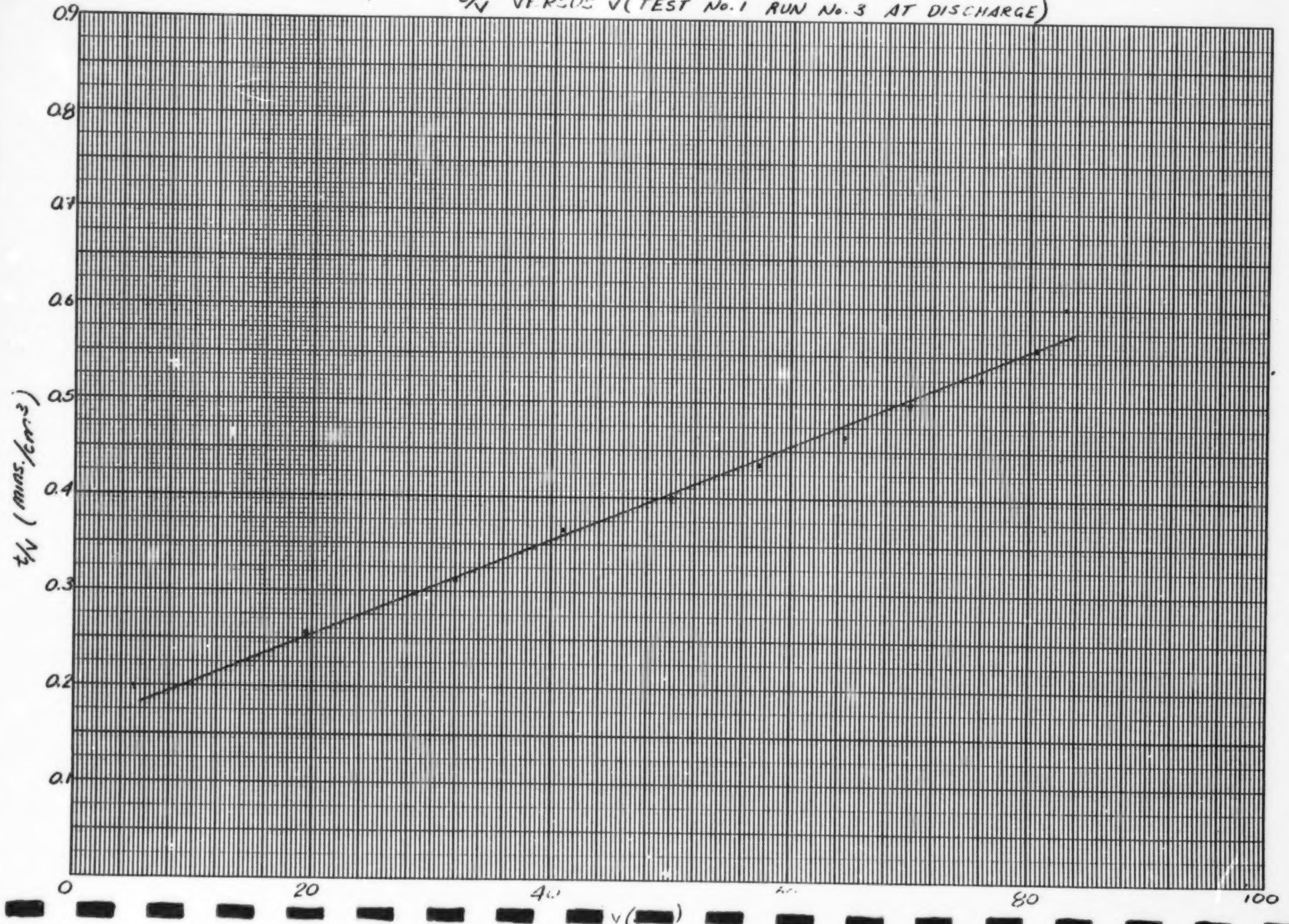

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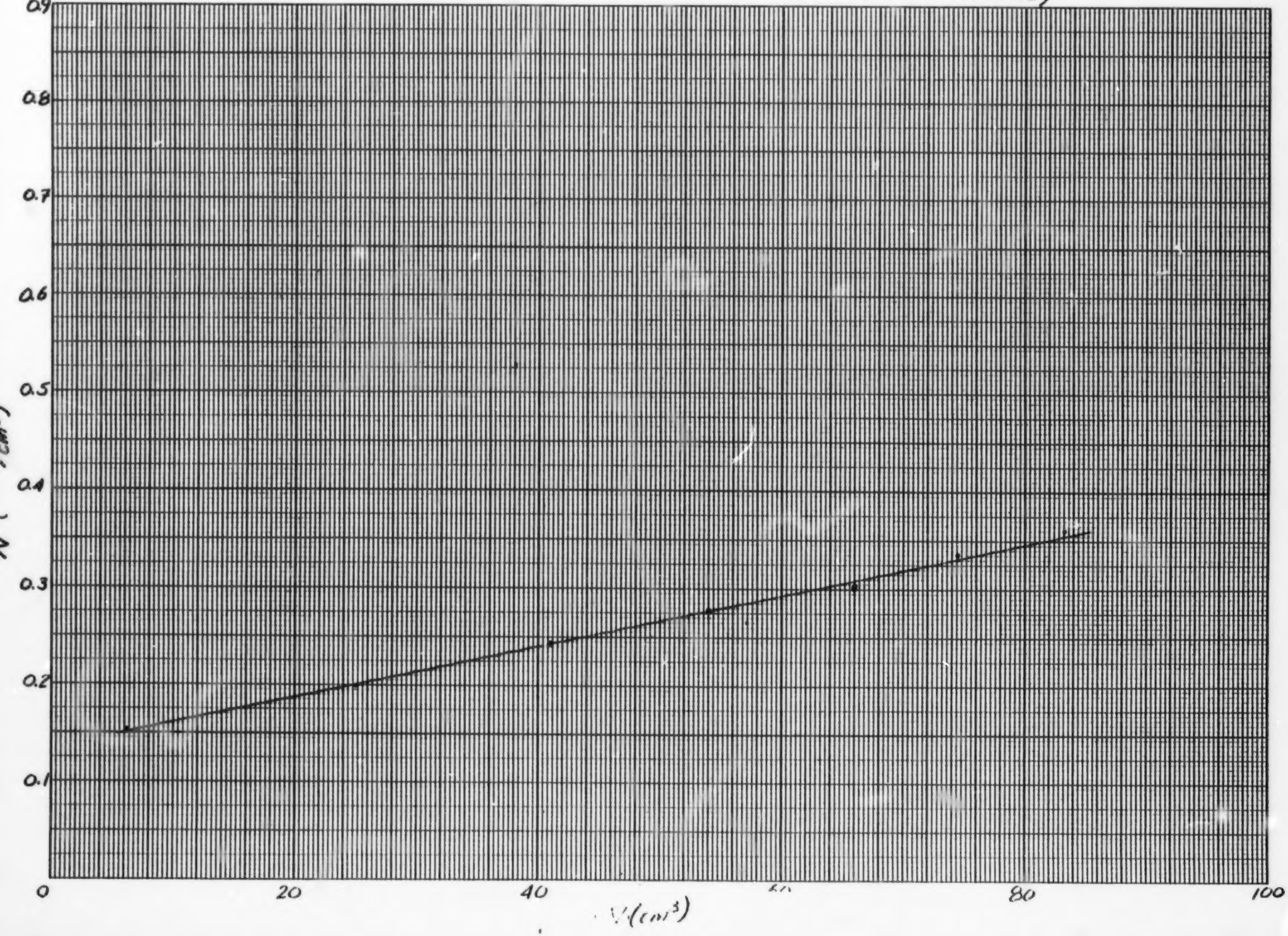

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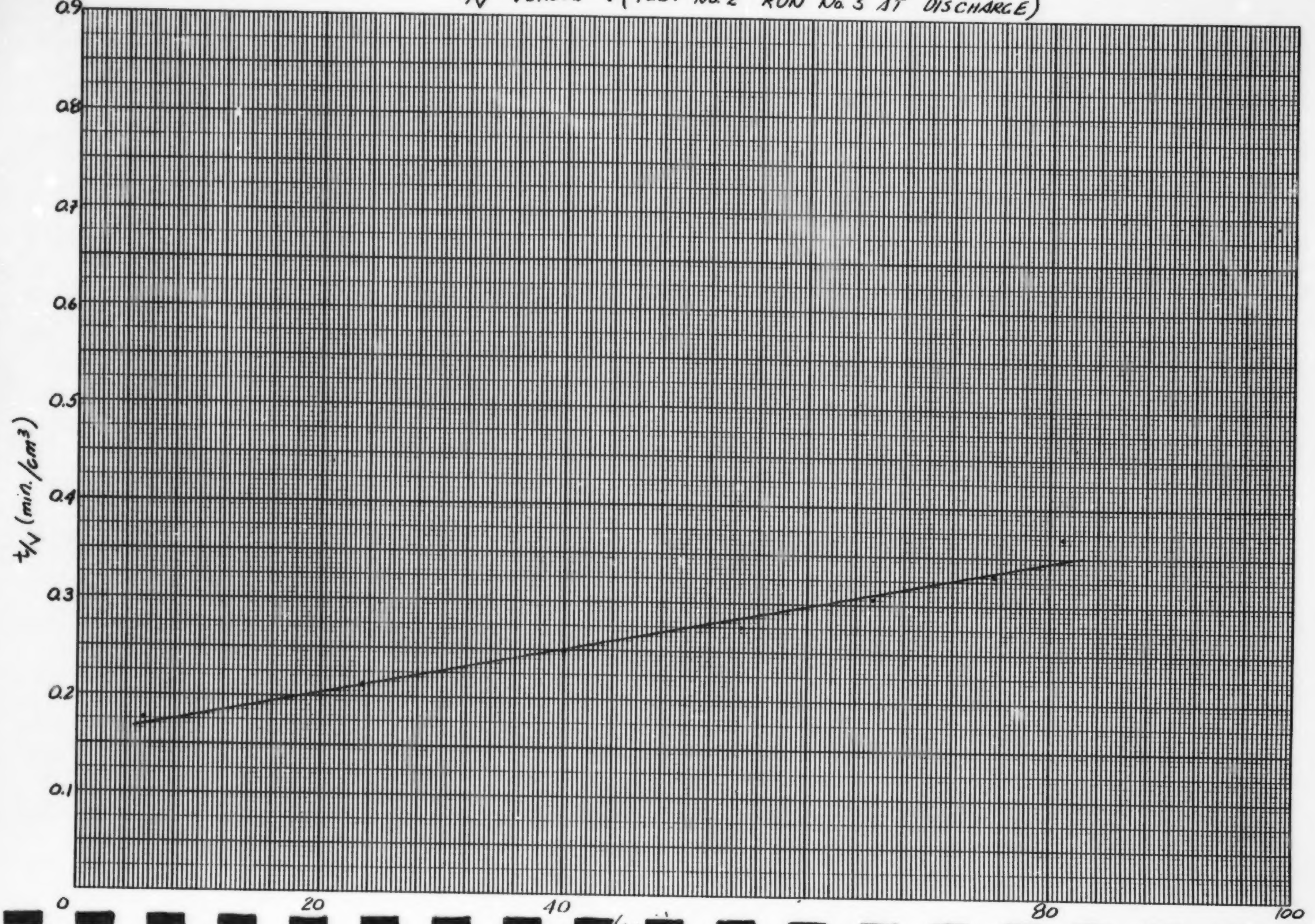
t/V VERSUS V (TEST No. 2 RUN No. 5 AT DISCHARGE)



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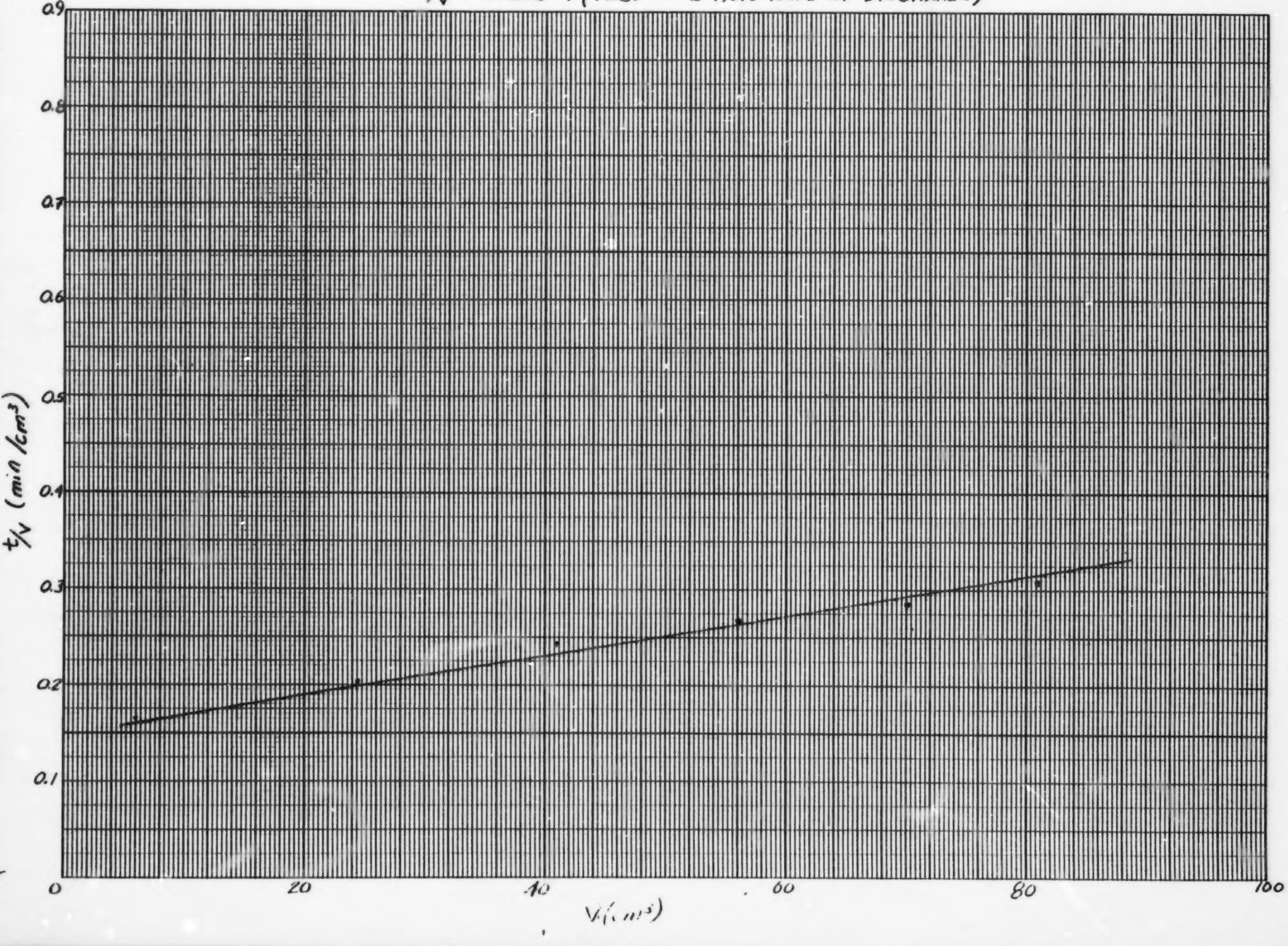

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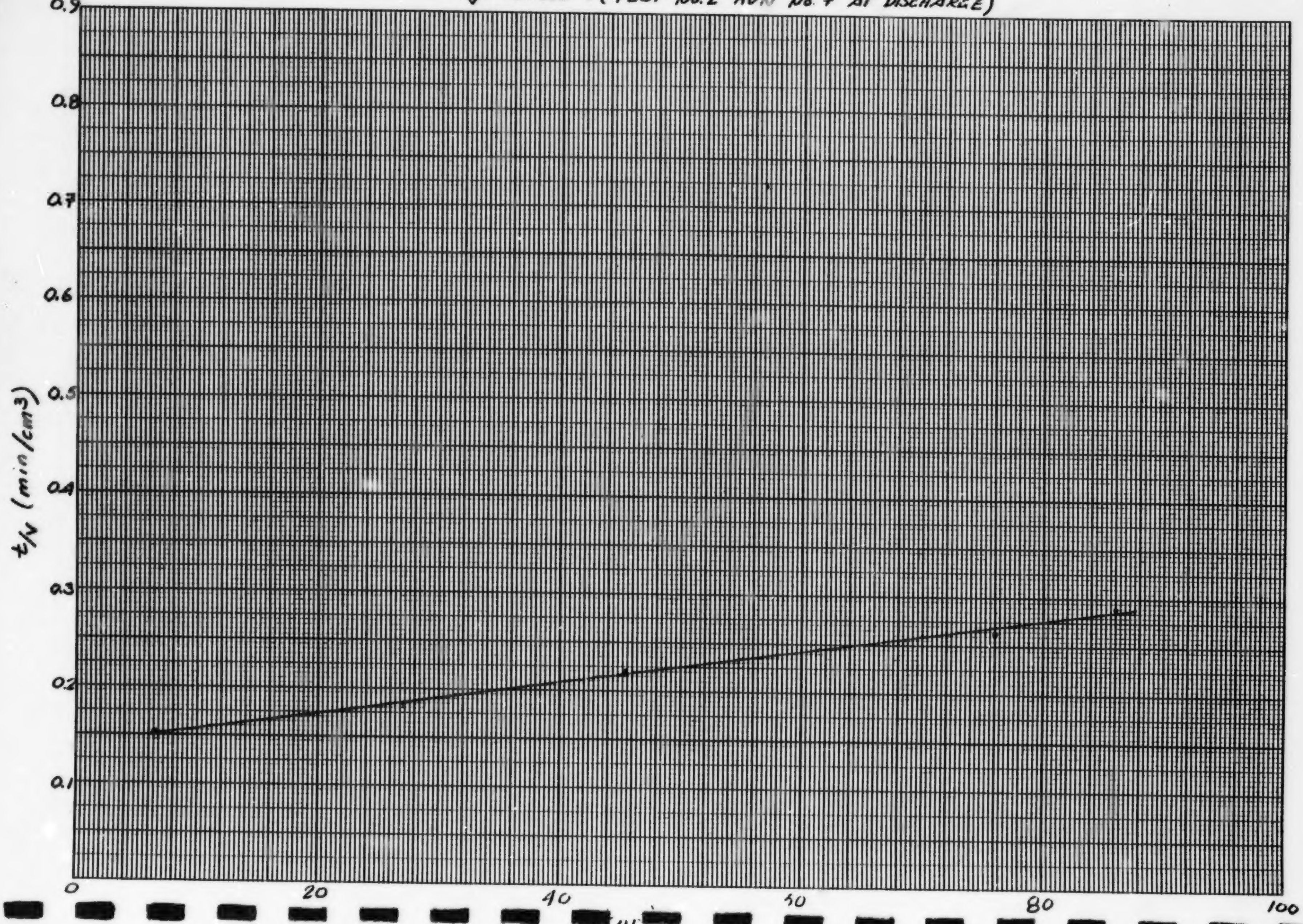

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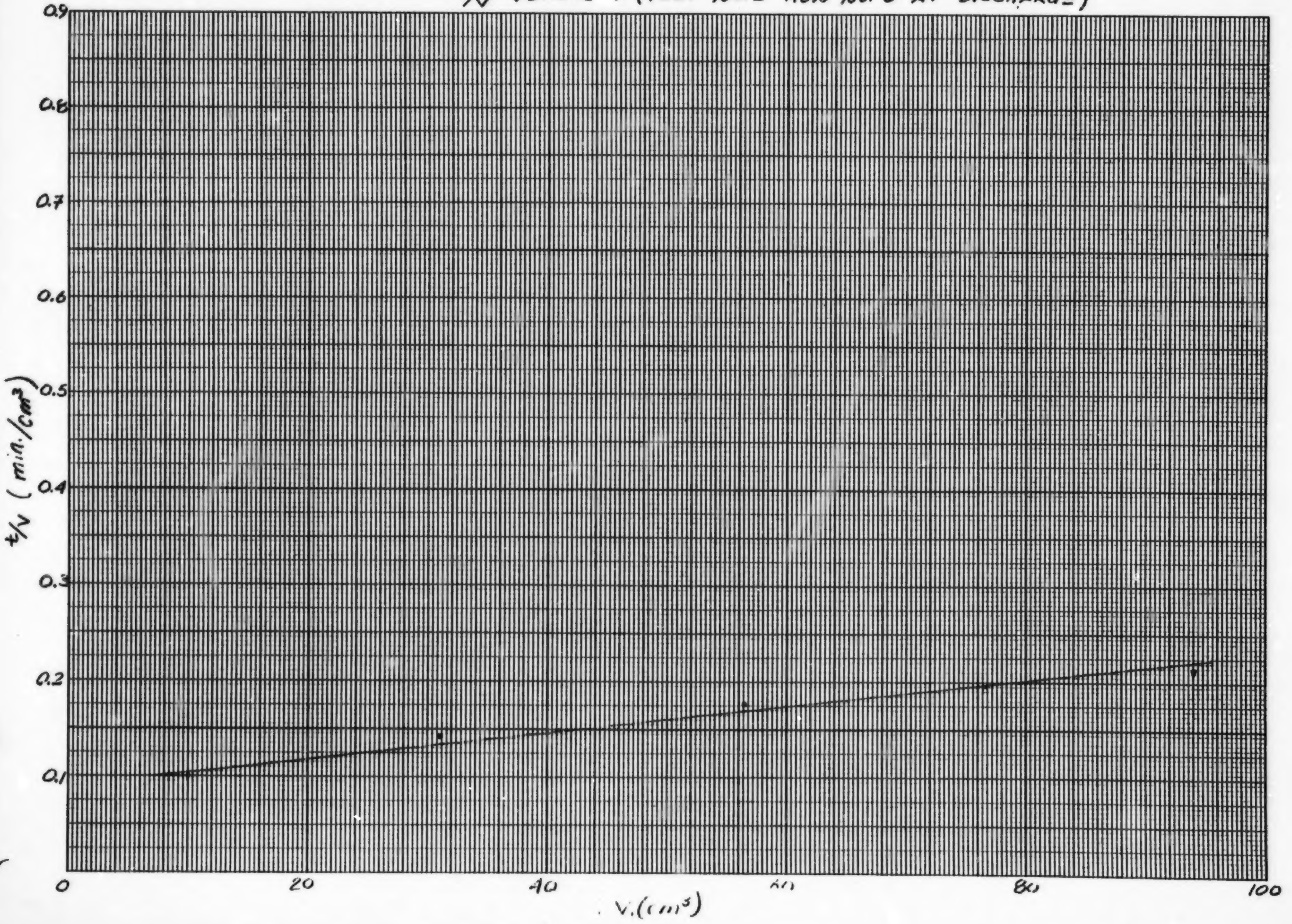

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MADE IN U.S.A.

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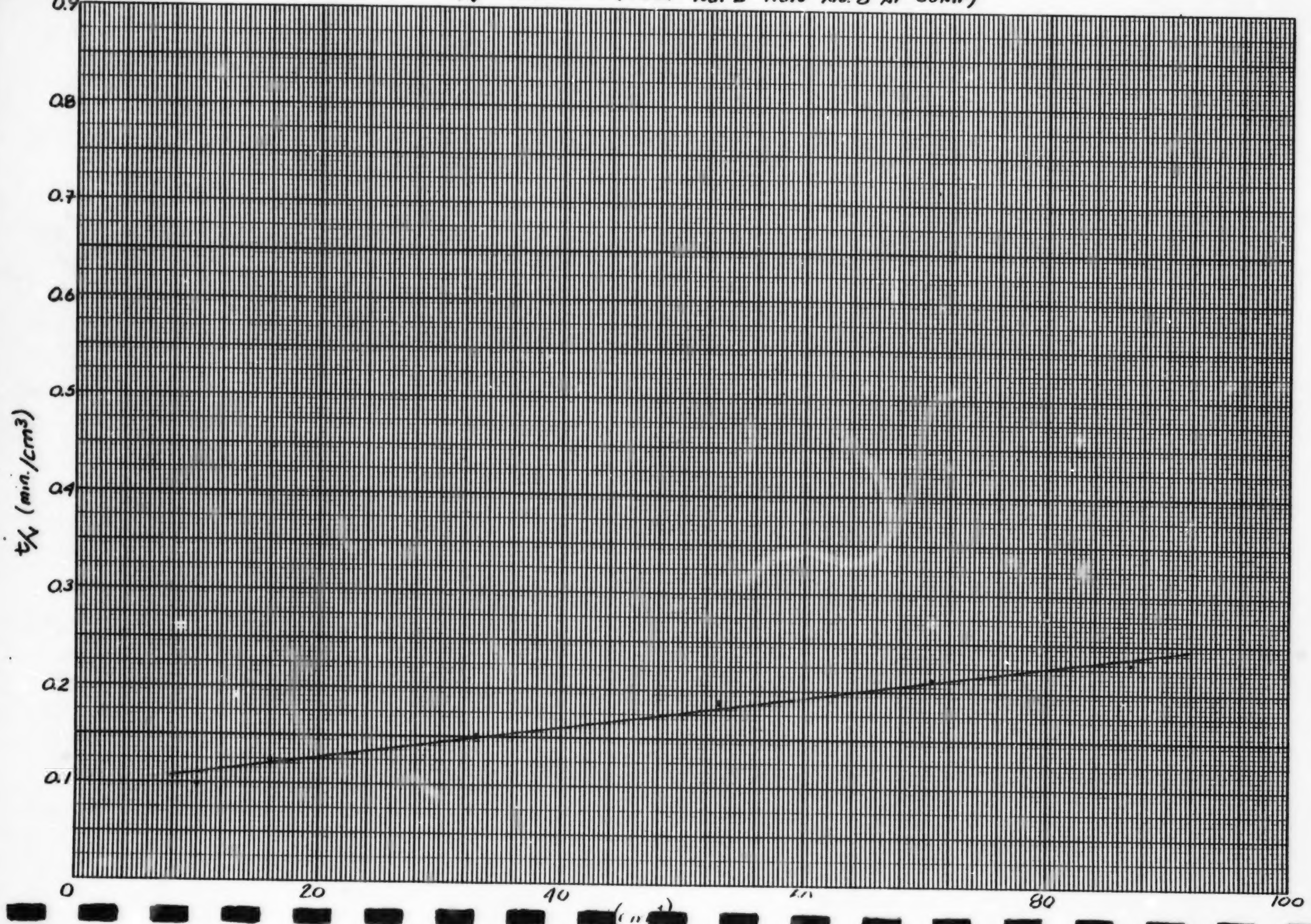

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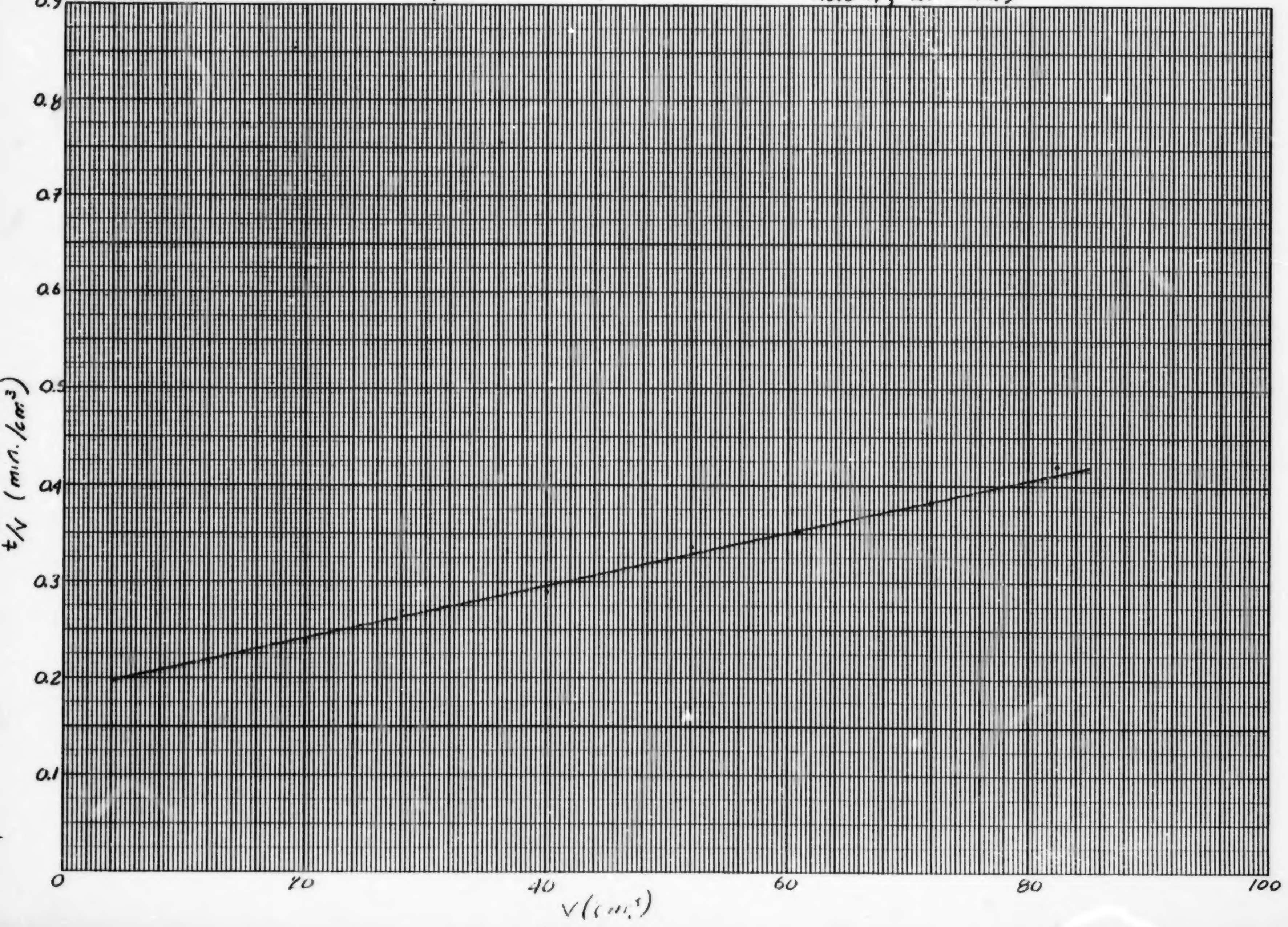

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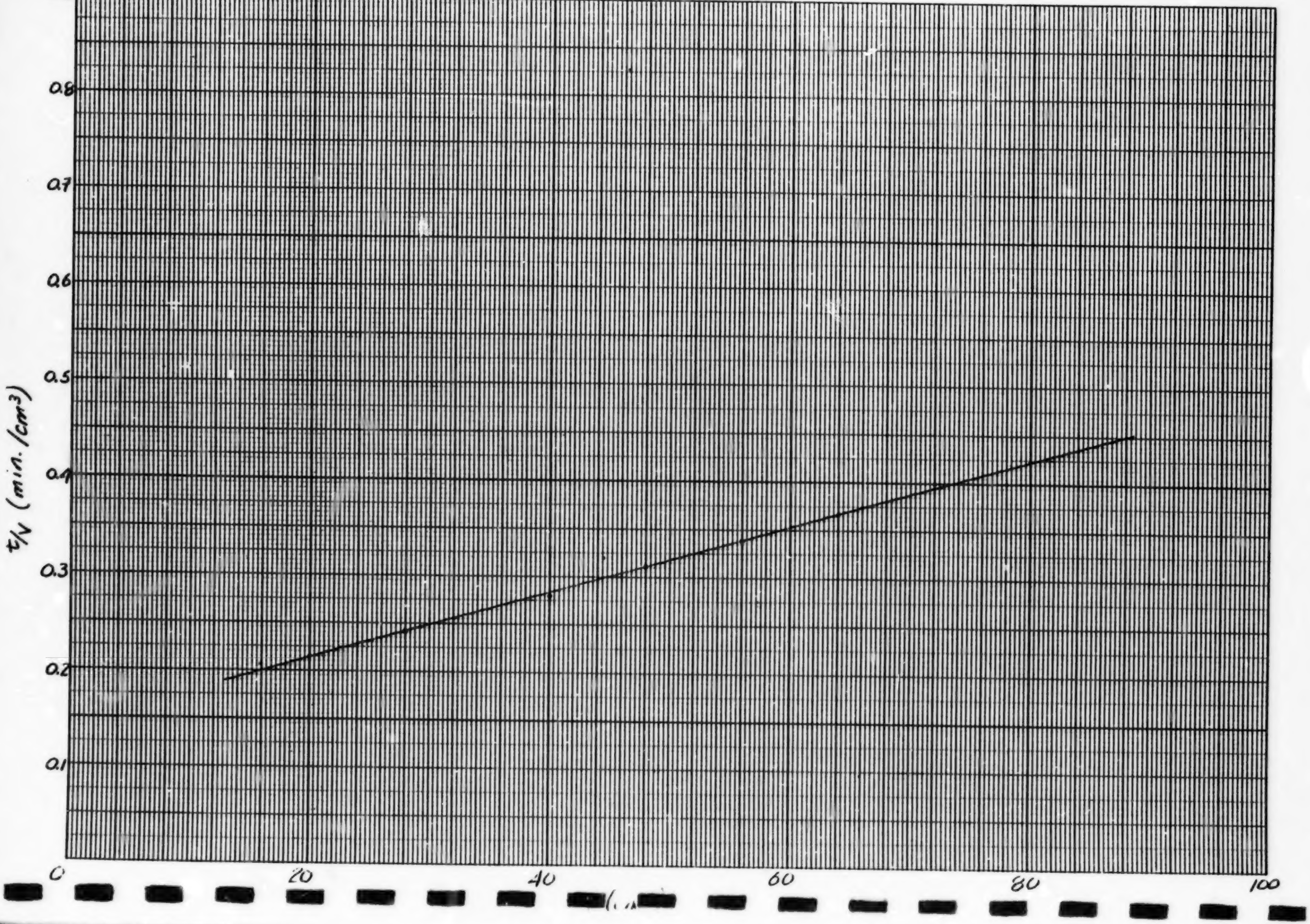

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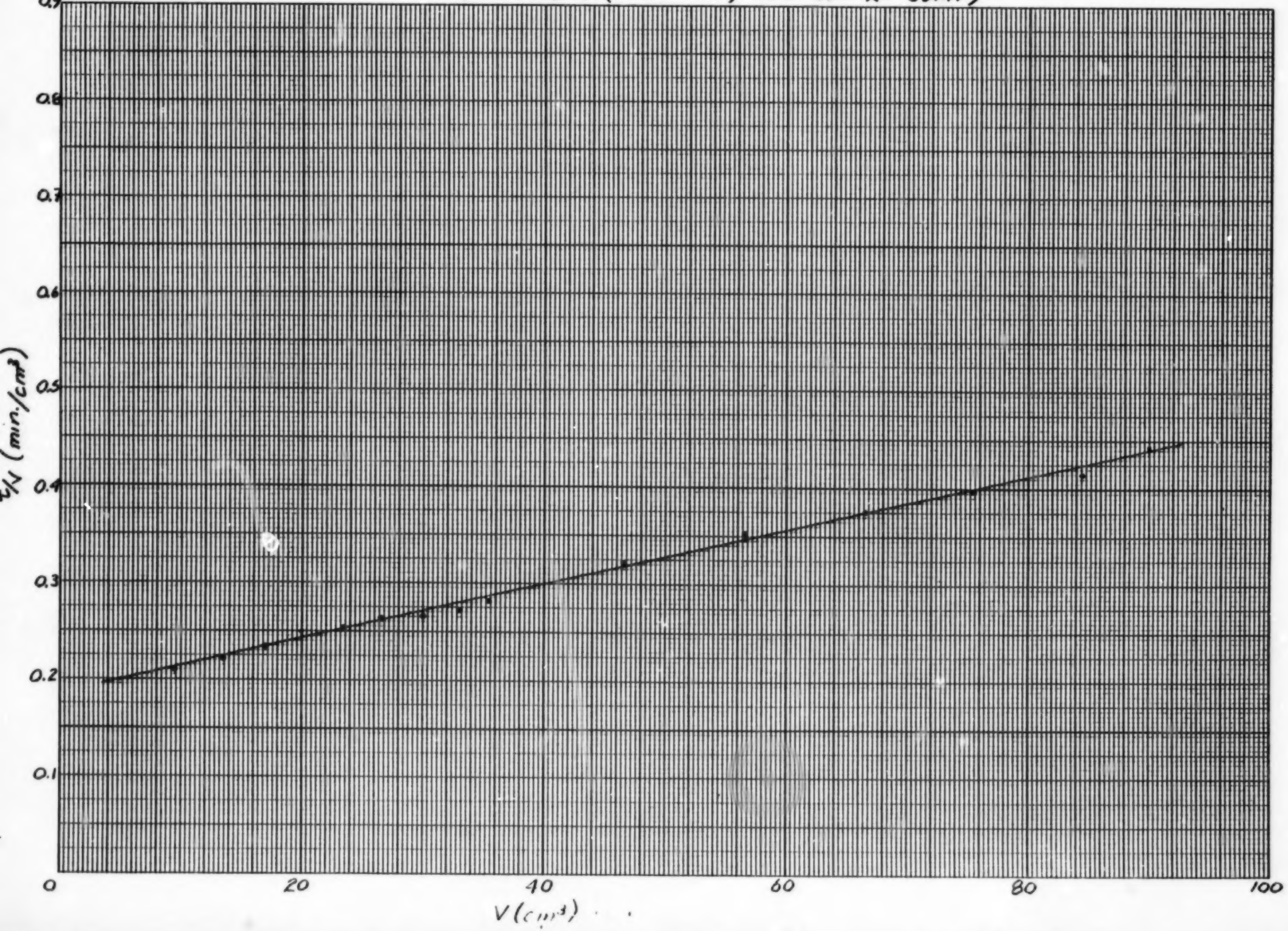

t/V VERSUS V (TEST No.1, RUN No.1 AT SUMP)

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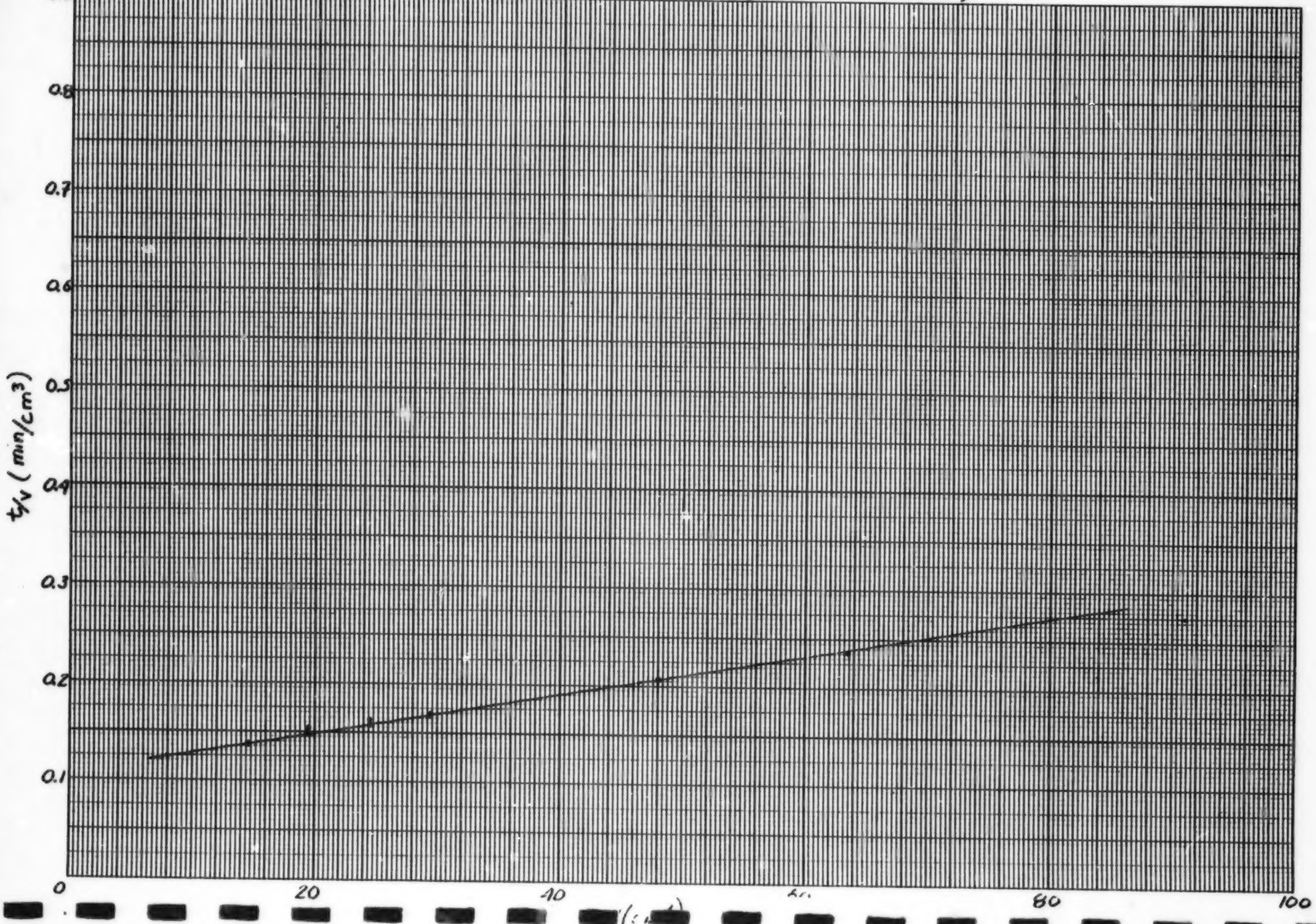

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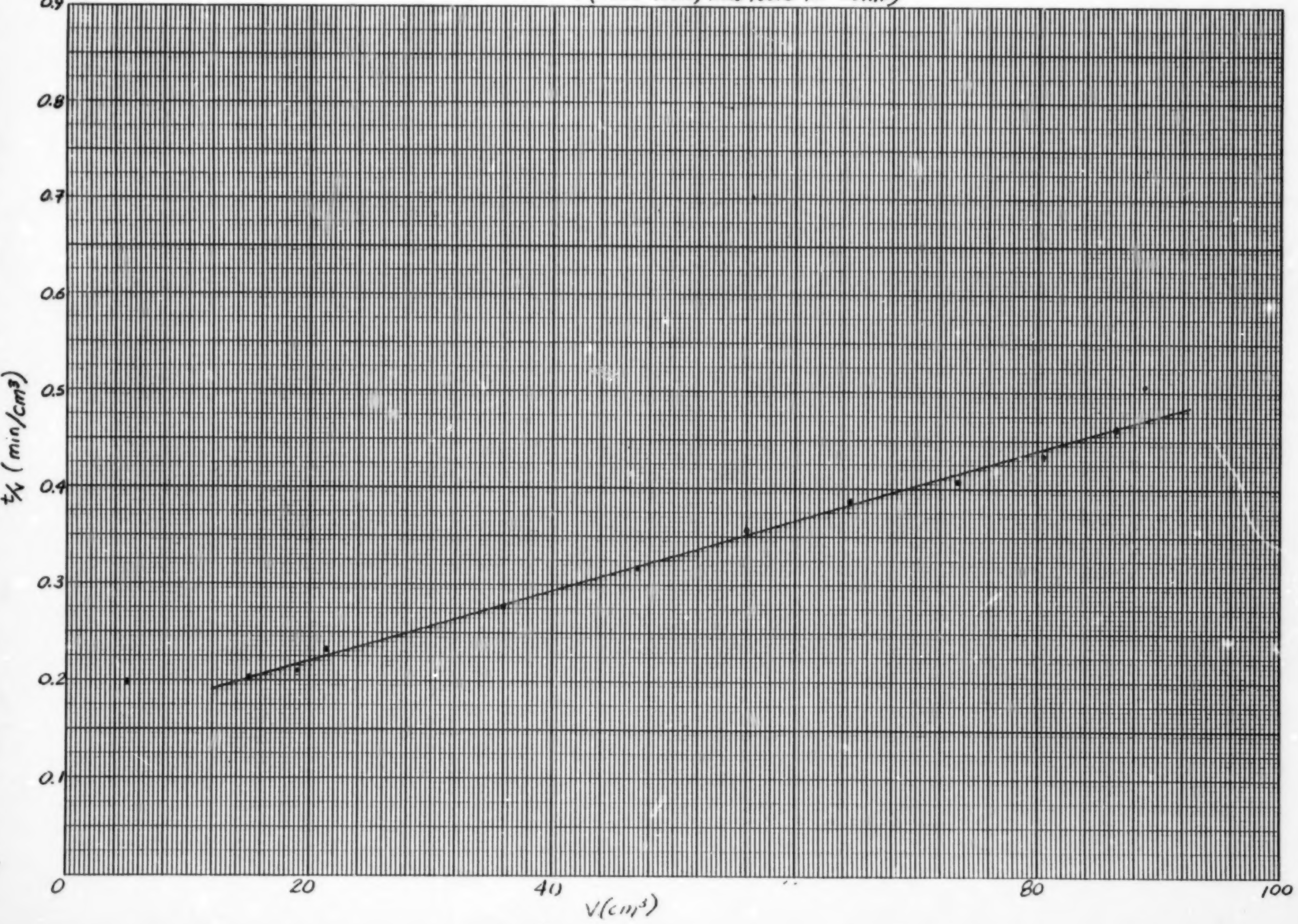

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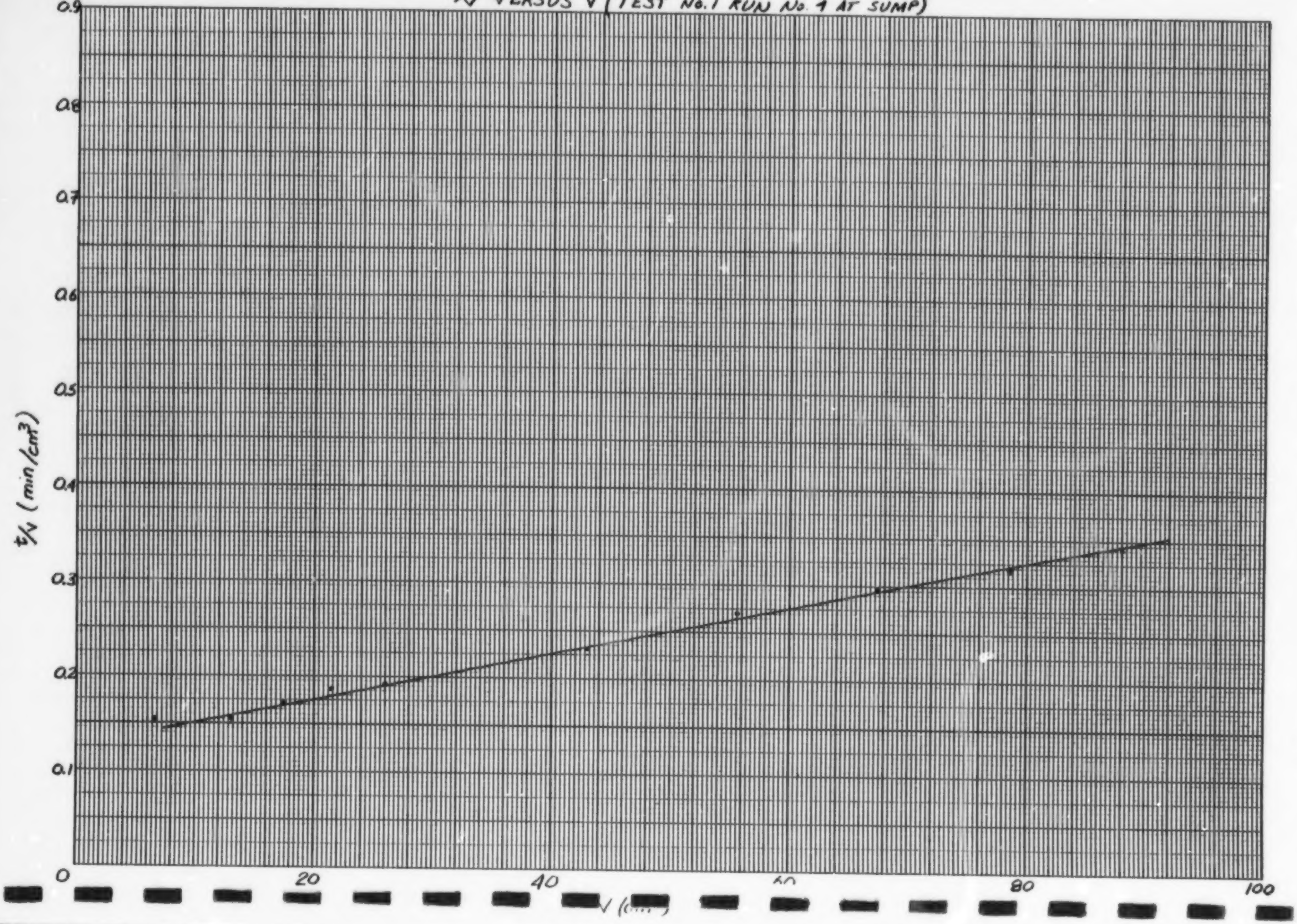

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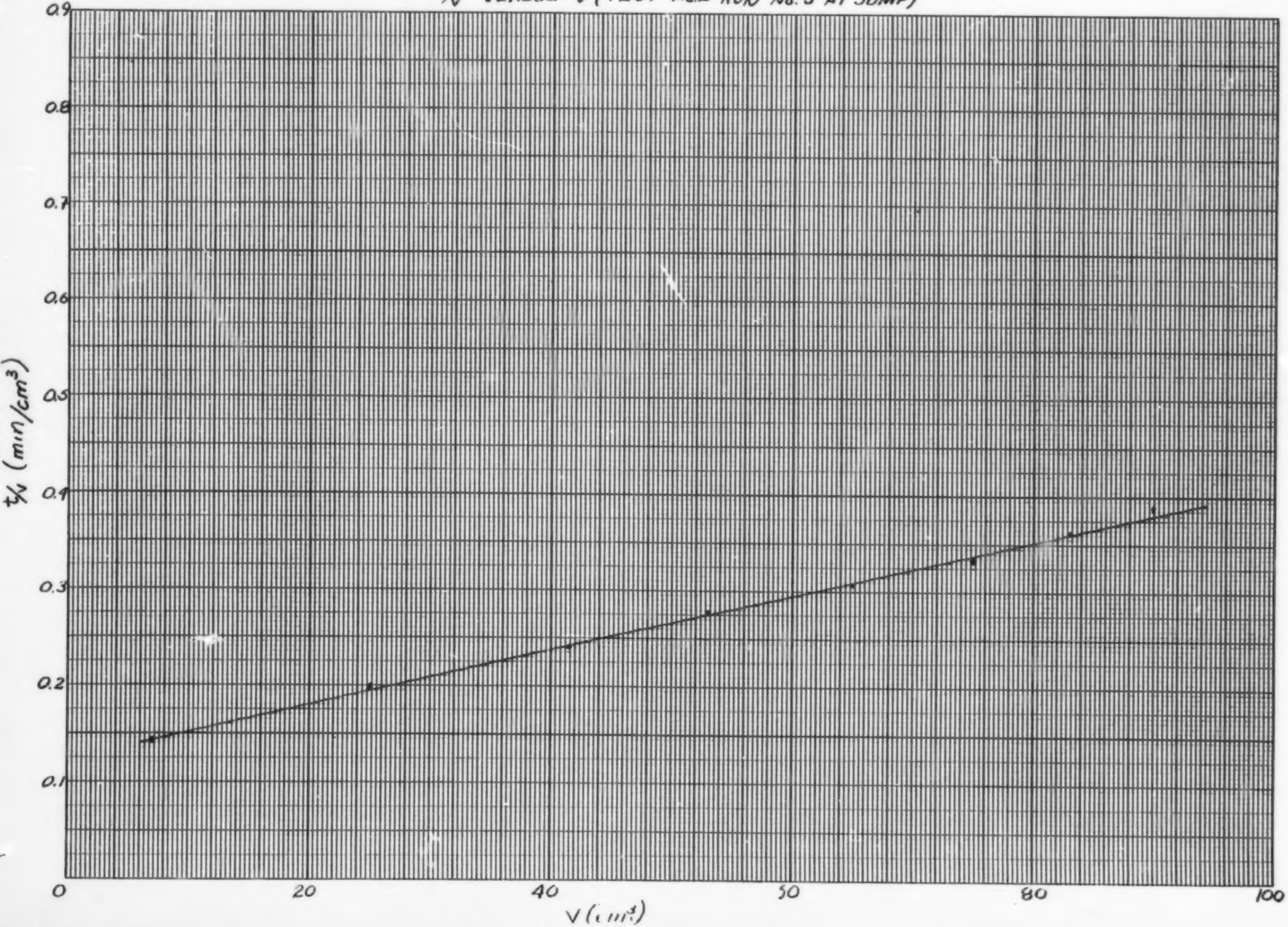

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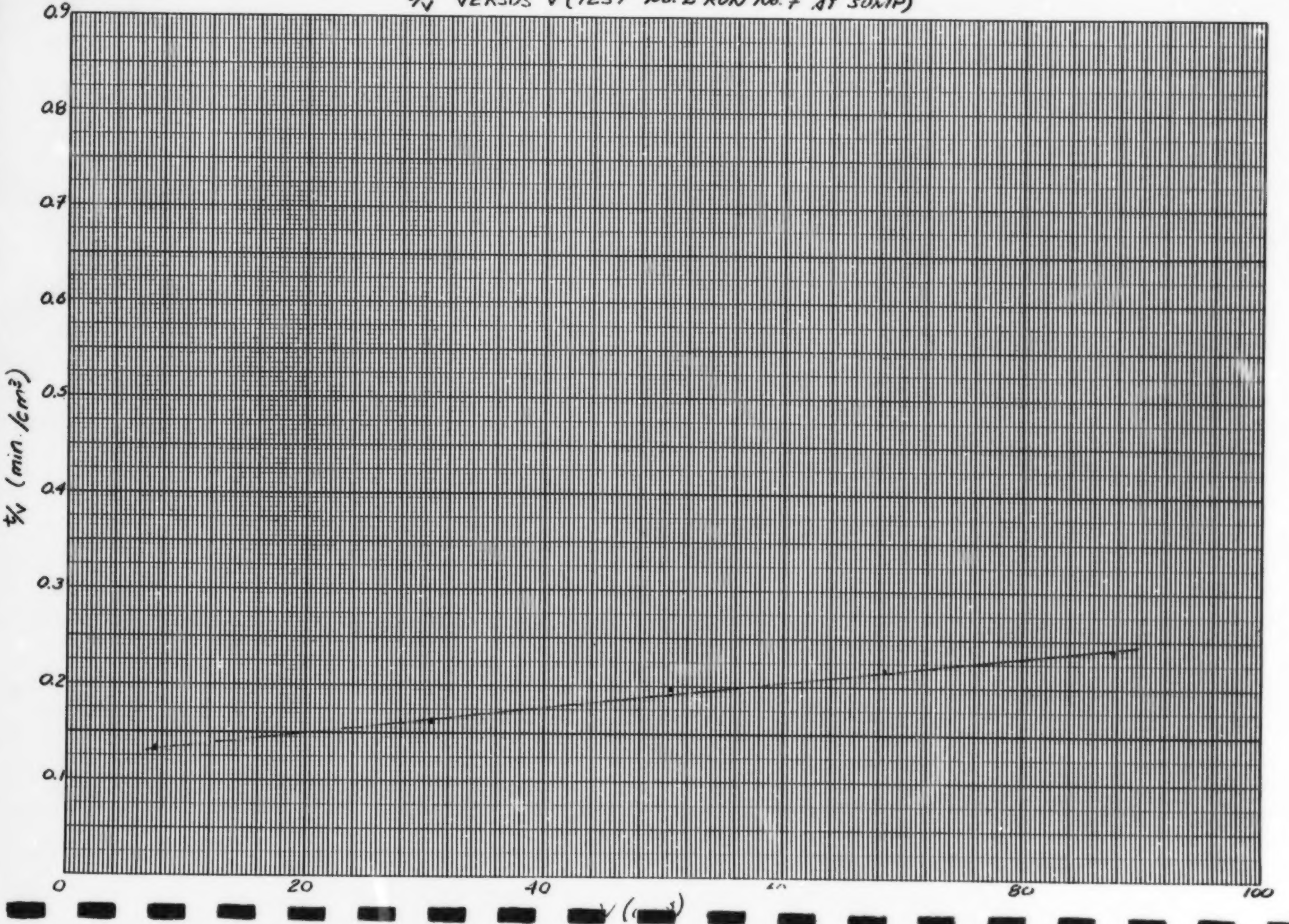

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DIETZGEN CORPORATION
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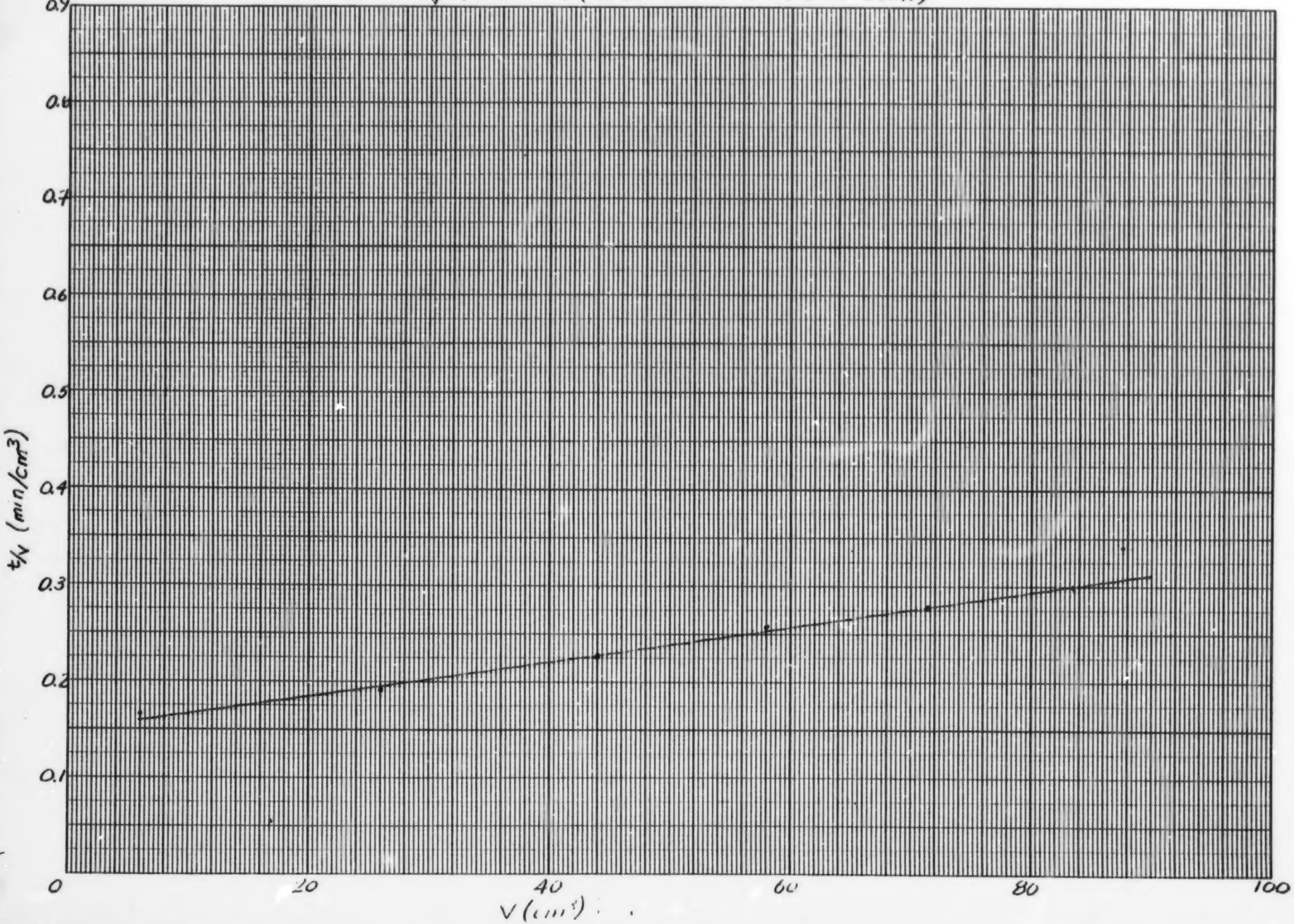

APPENDIX G

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REFERENCES

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